

# Metallurgical & Chemical Engineering

Volume XIV, Number 3

February 1, 1916

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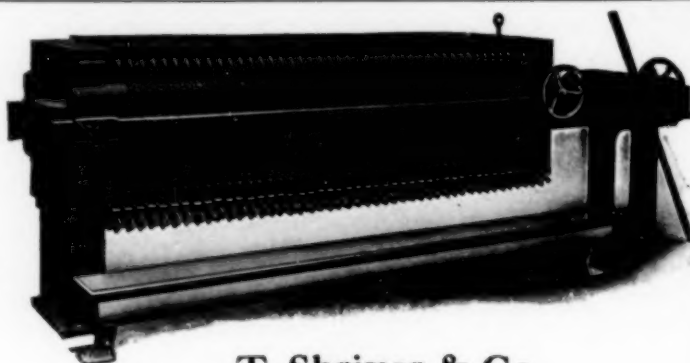
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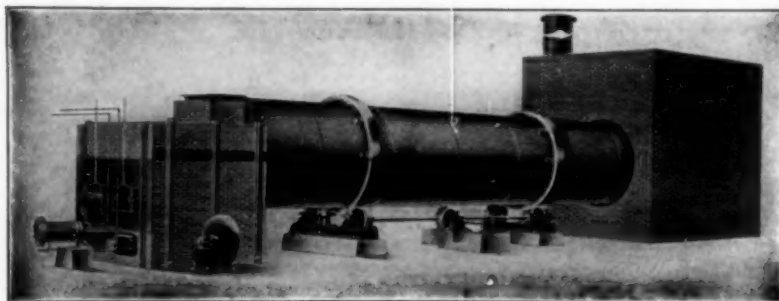
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## Shall the United States Be Self-Contained?

With so large a part of the world at war, even those at peace are beginning to feel unsafe. With passions aroused to fever heat there is no telling in many people's minds when, where and how the powers of wrath may rise against us; and the shocking comparison has been made of the present position of the United States with that of a very respectable old lady who goes out into the night with her hundred dollars safely tucked away in her stocking, little dreaming that even her legs are not immune and that there are prowlers at large who are without a sense of propriety.

This fear of an aggression of this country from the outside may or may not be purely psychological; its basis of reality may or may not be congruous to the intensity of the unsafe feeling. Yet the fact remains that the industries of this country while in peace with the outside world have been hit hard in many points by the European war, and the further eminently significant fact remains that those points where the country has been hit hardest are also the very points where it would be most vulnerable in case of war. For an army and a navy are useless without the means to maintain them, and the means consist largely in the self-containedness to meet a situation of war—and this very self-containedness has now been found wanting while this country is at peace. Time was when bows and arrows and swords and shields were the chief equipment of men at arms. At present without a great and complete chemical and metallurgical industry that supports itself in times of peace and can switch over to making war materials when called upon to do so, a nation is vulnerable in war and unprepared for peace. Strange it is, but true, that the making of dye-stuffs and of munitions of war are closely interlocked.

It is fair to say that upon the readers of METALLURGICAL AND CHEMICAL ENGINEERING a large part of the ability of this country to defend itself rests. Without highly and completely developed chemical and metallurgical industries neither the army nor the navy could hold its own if we were attacked. Bearing in mind all that has been said of that phase of economics which has to do with the taxation of imports, the facts remain that as things are, the self-containedness of this country is greatly dependent upon these industries, and also that, as things are, these industries cannot hold in this country if no import duties are applied. This does not mean that everything chemical and metallurgical should be protected and that manufacturers should be allowed to write their ambitions for profit into the revenue statutes. This would beget as great an evil as the other extreme.



One of the difficulties of the tariff in the past has been that we have had to treat it as though it were a case in court and but one of only two solutions of its many problems were possible—to determine whether it be generally high or generally low. This seems about all that we have been able to do. The congressman we have voted for may have been familiar with our affairs and anxious to help us, but has had little power to do so. He took his place at his desk like a good little boy at school and voted for the party leader as speaker of the House. The speaker named the committees and allotted membership in each—according to geography. If manufacturers were in trouble at their works, and needed an engineer to help them out, they would not want for that purpose a lawyer from a distant state, selected for geographical reasons. And yet that is about as near as they have been able to reach the question what import duty the Government should charge on the merchandise that they produce. The Congressman's advice might have been good in a case at court, but he has been a rare bird indeed if he could get the chemical situation into his head. It was not his fault; in minor part it was due to his lack of time and training. In major part it was the manufacturer's fault.

When a tariff bill has been introduced, manufacturers—from the chemical and metallurgical fields as well as from others—have been likely to flock to Washington and crowd over each other and lobby and interview and appear at hearings and claim all that they dared ask for. The members of the Committee on Ways and Means have usually been helpless. They could not have heard all that was offered them if they had had ears all over their heads in the place of hair. And if they had had this monstrous endowment they could not have remembered what they heard. And if they could have remembered it they could not have correlated it and brought it into form and into the semblance of truth. For in the past all the time the manufacturers have been contradicting each other. The one using the finished product of another as one of his raw materials wanted that product free. The man making it wanted a dollar a pound duty imposed, but he wanted his raw materials, the intermediates, free. The intermediate man made a similar plea for his product and the man back of him did likewise, all uttering the same cry, but calling for a different law. This is somewhat overdrawn, nevertheless it is a caricature of something that has been real. No wonder it is said congressmen have taken to drink. And the result of it all has been that the United States has never had a good, well constructed, suitable tariff law.

Yet two bright rays fall into this dark-in-dark picture. It is a picture of the past. The future may be different. In its present troubles this country has learned something. The manufacturers have learned something, and the Government has learned something. How much the manufacturers have learned became manifest at the hearings before the House of Representatives Committee on Ways and Means on the Hill

bill for a dyestuff tariff last month, of which a full account may be found on page 125 of the present issue. It was not a series of pleadings of everyone for his own pocket. There was pretty general unanimity of opinion that the whole matter must be considered from a higher plane, in a co-ordinated manner, with this one principal leitmotiv: that this country shall be self-contained. For the part it has played in crystallizing this sentiment, the Chemical and Dyestuff Committee of the New York Section of the American Chemical Society and its chairman, Dr. Hesse, as well as the president of the national society, Dr. Herty, really deserve great credit.

The other ray of hope—and possibly the greater wonder of the two—is, of course, the reported conversion of the Administration to the necessity of a non-partisan permanent tariff commission. There was once such a commission. It went out after the Democrats came in. If it now comes back through the Democrats it is hard to see how any party can ever afford to let it go out again. There is good reason for rejoicing and to the Administration high praise is due for having the courage of freshly acquired conviction. But for the representatives of the chemical industries to think that now their task is ended would be a frightful and fatal mistake. The good work begun by the Chemical and Dyestuff Committee of the New York section of the American Chemical Society and by others needs to be continued, broadened, strengthened, intensified. The tariff commission—if it comes into existence—will need all the help and advice it can get from those thoroughly familiar with the technical details of all the industries. Let the chemical and metallurgical industries be in the front rank to render freely such service in co-operation.

And yet when all is done that is humanly possible for the chemists to do, more remains to be done. Dr. Baekeland was right when he said in his Perkin medal address (published in full on page 151 of this issue) that if we turn our present unparalleled chances of success for creating a great American chemical industry into a gigantic fiasco, the whole blame should not be placed on our chemists. Let Dr. Baekeland's address be read—broadcast throughout the land—by our business men, captains of industry, and lawmakers. Let them understand that American chemists are striving not merely for themselves but for the self-containedness of the American nation.

### The Future of Steel Prices

In the past dozen years there have been three high levels in steel prices, in 1907, at the close of 1909, and at the close of 1912. The present average of finished steel prices, not for prompt shipment but for shipment at mill convenience, is about \$2 a net ton above the first high point, \$6 to \$7 above the second and about \$8 above the third. It required a period of about two years, with continued heavy demand and mills working at high pressure, to develop the high level of 1907. The present level has been reached in thirteen months, and two-thirds of the total advance has occurred in the past four months of the thirteen.



Clearly the steel market has passed entirely beyond its ordinary bounds, as established by the precedents of a dozen years, and yet prices still show a rising tendency. The natural inference is that eventually the readjustment will come, that prices will fall. Meanwhile, however, new conditions may be established whereby prices may not fall to the preceding low levels. It is certainly important to consider the probable bearing of such new conditions as we see being established at present, or can foresee as likely to develop.

In the iron and steel industry great changes in processes of manufacture occur in a few years. Truly wonderful economies have been introduced, but these do not show in prices quoted in money. In terms of money, steel sold at its lowest prices in 1897 and 1898. In terms of mental and manual effort expended and intrinsic value of raw material and equipment used, steel is to-day produced at very much lower cost than at that time. For instance, wages per hour are very much higher while in addition the mental and manual effort per hour of the workman is undoubtedly decidedly less. Again, the intrinsic value of the ore used is very much less than formerly, the iron content being lower and the material to be fluxed off, involving additional consumption of limestone and coke, is much greater. For another of many illustrations that could be given, the equipment used, while costing much more, is produced by the builders at much lower cost, measured in terms of mental and manual effort expended in its building, and in its efficiency for the purpose, than formerly. If the iron and steel industry were given to-day the same raw materials and the same wage rates and labor performance as in 1897, combined with present practice and equipment produced with the same low-priced labor, it would be able with such a combination to sell steel at astonishingly low prices.

While improvement in processes and equipment is bound to continue, it cannot be expected that progress can be so rapid in future as in the earlier years. The curve representing cost of production in terms of effort expended and consumption of material cannot become tangent to the line of perfection, but it has some of the characteristics of an asymptote. It seems reasonable to conclude therefore that the future of steel prices, measured in terms of money, will hinge more upon economic conditions than upon technical progress.

Sweeping changes have been brought about in economic conditions by the war, and probably still greater changes are to occur in the future. For decades the iron and steel industry has been supplied with labor chiefly through immigration. There have been successive changes in the source of the immigration, until in recent years it has been chiefly Croatian, Slavonian, Italian, Magyar, Polish, Roumanian, Russian, Ruthenian and Slovak. Prior to the war there had been noted a tendency in this immigration to decrease relative to the requirements of the industry. Economic conditions resulting caused wages in the iron and steel industry to rise somewhat more rapidly than the general wage level of the country. Early in 1913 the industry made a general wage advance at a time when there was no corre-

sponding general advance in wages. The war has caused immigration almost to cease, and this change has affected the iron industry much more than it has affected industries in general. The net change in the population of the United States occasioned by people entering and leaving the country was an increase of 754,205 in the fiscal year 1913 and an increase of 687,065 in the fiscal year 1914, making an average increase of 60,000 per month. From July 1, 1914, to Dec. 1, 1915, the net increase was 124,033, or 7300 per month. Thus the war has been causing a deficiency to accumulate in our population at the rate of 52,700 per month or 630,000 per year, and this loss bears much more upon the iron and steel industry than it does upon industries in general. At the present time a general advance in wages is being made in the iron and steel industry, at a time when wages in industries as a whole are not being specifically advanced.

One can scarcely conjecture what will occur with respect to immigration when the war closes. One does not even know what the conditions will be, how seriously territory has been or will be ravaged, what effort would be required to restore it, and what power there will be to make the effort. The balance of probability appears to be that there will be no large immigration, or at any rate such as would make up for the deficiency now accumulating and for the industrial expansion now in progress in the United States. The steel industry, therefore, seems to face for the future distinctly higher wage rates, relative to those which may prevail in industries generally, than in the past. Measured in commodity values steel should, therefore, be expected to sell at higher rates than in the past.

We are accustomed to seeing commodity values and security values move together. When credit is readily obtained the value of both securities and commodities tends to advance, and when credit conditions are strained the reverse occurs. The war tends to divorce these trends from each other. It occasions both a great destruction of commodities and a great deal of borrowing. At the close of the war the demand for commodities will be out of proportion to the ability to borrow. Commodities will tend to be higher in price than normal relative to the value of securities. The demand for commodities that can be paid for in current effort, pay as you go, will be greater than the demand for commodities that are to be paid for with credit, by the flotation of securities. Steel falls more in the latter category than in the former, and in this respect it will be at a disadvantage. Man will have to make the effort to build up a greater credit structure than has ever existed before. How successful the effort may be remains to be seen, but there will be the foundation that has been lacking for many years, the certainty that there will not be a great war for a long time at least. For many years past a distinct element of timidity has been observable in capital abroad, ascribed openly to the fear of a continental war. If the credit structure can be built up, then all the elements will be present for higher prices for steel, relative to commodities in general, than have prevailed hitherto.

## Reader's Views and Comments

### Hydrometallurgy of Zinc and Lead

#### Electrolytic Zinc at Bully Hill

*To the Editor of Metallurgical & Chemical Engineering:*

SIR:—I wish to be allowed to correct what seem to me some slightly inaccurate statements of Messrs. Lyon, Ralston and Cullen in your issue of Jan. 1, page 30, in their article on "Hydrometallurgy of Zinc and Lead," regarding zinc processes, more especially as practised at Bully Hill, Cal.

Some two years of conscientious effort were expended in the development of the zinc hydrate process described, and excellent zinc cathodes were made during a fair share of this period.

It also appeared that zinc could be made by this process at a cost which would make commercially possible the production of from 10 to 20 tons of zinc per day at Bully Hill.

Both the Bully Hill Company and the General Electric Company, the owners of the Bully Hill property, however, were quite as much interested in the development of a generally and widely applicable process, and they finally concluded that the zinc hydrate process could not compete to advantage in the Montana, Utah, Idaho district, e. g., which the writer considered the most promising one in the country, and other important districts.

As a result, the zinc hydrate process was set aside for the time, and substantially a method that was earlier tried with some success, but with modifications, was reverted to, viz., direct electrolysis of zinc sulphate with regeneration of acid, and this has been since continued.

The revised process was planned out in October and November, 1914, was put in practice in March, 1915, and has been producing 300 to 400 lb. of zinc per day most of the time since then—practically the full capacity of the experimental plant.

During this period the only raw materials entering the plant, aside from materials of construction, etc., have been fuel oil for roasting and melting zinc. More than enough acid is fixed in roasting to supply losses, and chemical reagents have been used for analytical purposes only.

The process, as it stands, is partly old, but was never before made commercial. The ways and means, mechanical and other, are perhaps new in detail. Certain very valuable results of the work are a wealth of collected data, intended to fix the approximate limits, as nearly as may be, between which profits can be produced under somewhat varying conditions with different zinc ores.

The authors of the article which attracted my attention state that the electrochemical zinc plant is extraordinarily expensive as an investment, as compared with the older retort process plant.

This is only true, I think, in any or the usual case, as the primary power station may be taken as a part of the electrochemical plant.

A completely equipped electrochemical zinc plant of 200 tons zinc per day capacity at Butte, Mont., including substation (but not primary generating plant), offices, laboratories, repair shops, etc., would cost, I estimate, between \$2,400,000 and \$2,600,000. These figures were



FIG. 1—OUTPUT OF BULLY HILL ELECTROLYTIC ZINC FOR TWO OR THREE WEEKS

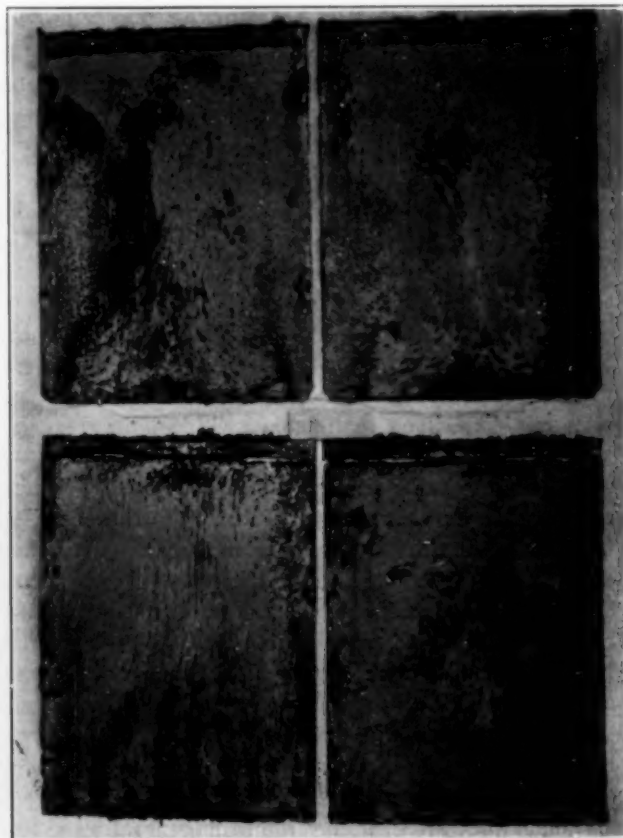


FIG. 2—STATIONARY CATHODE DEPOSITS OF ELECTROLYTIC ZINC, 24 IN. X 36 IN.



worked out directly in considering the Butte & Superior Copper Company's property.

An equivalent retort process plant, including its roasters, pottery, etc., but not a sulphuric acid plant, would evidently cost \$2,800,000 to \$3,200,000, depending upon its location.

An electrochemical plant producing 10 tons of zinc per day would cost \$200,000 to \$300,000, depending upon location, etc. The former figure would cover a zinc plant auxiliary to a going smelter—the latter would be more nearly approached by a plant dependent upon its own repair shops, offices, laboratories, etc.—particularly if the roaster gases required special treatment before being released.

The writer does not believe that a retort plant of 10 tons of zinc per day capacity could be put in operation for particularly less than these figures. The operating costs would most evidently mount more rapidly with a decreasing production rate in the case of a retort plant than in the case of the electrochemical plant.

Messrs. Lyon, Ralston and Cullen may also mislead a little, I fear, when they state that "extraordinarily cheap" power is essential. *Cheap* power is likely to be essential, it is true, especially where no higher than a 60-per cent zinc concentrate is treated.

Butte-Superior concentrates, 55 per cent zinc, could easily carry a power rate of \$25 to \$30 per horsepower-year. Zinc ores with 25 per cent to 45 per cent zinc could carry somewhat higher power rates so long as the retort process continued to fix the value of zinc ores or zinc concentrates delivered to the electrochemical plant.

These power rates exceed American Niagara rates by 40 per cent to 65 per cent, and exceed Norwegian rates by some hundreds per cent.

What other electrochemical industry could afford \$25 to \$30 per horsepower-year in Montana in normal times and with normal Montana labor costs?

Ferrosilicon could not, except with 50 per cent alloy selling consistently at \$70 or better; calcium carbide might with a developed Western market; atmospheric

TABLE I—COSTS PER TON OF ZINC

	Retort Process, Oklahoma	Electro- chemical Process Butte, Montana
Plant capacity tons zinc per day	200	200
Cost per ton zinc:		
Salaries	\$1.25	\$0.93
Labor	11.30 (\$1.75 and \$2)	6.00 (\$3.50)
Gas at 4c.	2.93	....
Coal at \$2.	1.67	....
Power at \$26 hp. yr.	....	14.65
Clay	0.63	....
Repairs and sundries	1.04	4.14
	\$18.82	\$25.72
Fixed capital charges 16½ per cent first cost	6.36	5.70
Total treatment cost	25.18	31.42
Freight on concentrate to Oklahoma	16.62	0.00
	\$41.80	\$31.42
Freight to St. Louis on zinc	2.60	9.00
Freight to New York on zinc	7.20	10.00
Treatment cost and freight per ton zinc:		
F.o.b. St. Louis	44.40	40.42
F.o.b. New York	49.00	41.42
Above figures neglect mining and milling costs to produce concentrates; also neglect relative recoveries of zinc values which would be:		
For retort process, say	87.0%	....
For electrochemical process	....	93.0%
Correcting for relative recoveries, the relative treatment and freight costs on above basis would be about:		
For St. Louis delivery	\$44.40	\$37.06
For New York delivery	\$49.00	\$38.06
Equivalent cost per lb. zinc	2.45c.	1.903c.
Net value of silver, lead, copper in residues from Butte-Superior concentrate (26 oz. Ag.)	\$7.20	\$22.70

nitrogen fixation could not; aluminium could, were there any necessity for it.

That electrolytic zinc is commercially possible in Montana is indicated by the estimates in Table I, referred to above, made two years ago, and only revised slightly in the light of later knowledge and develop-

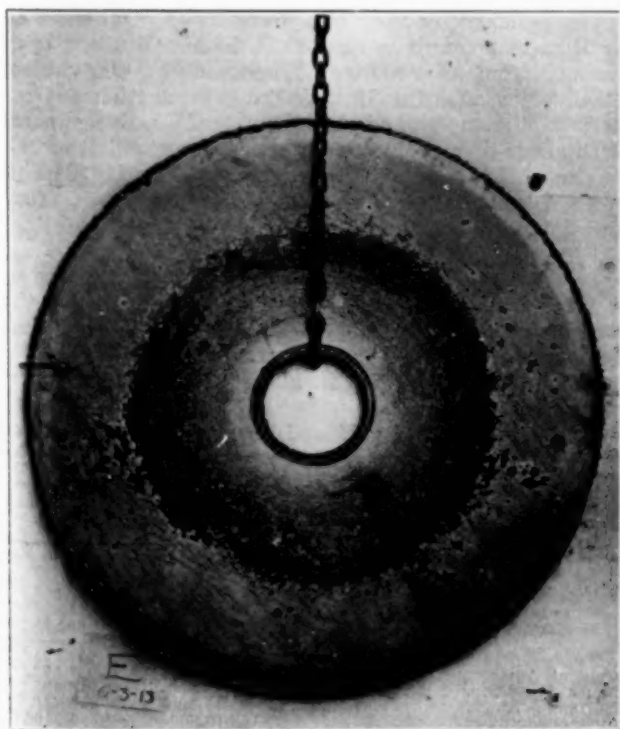


FIG. 3—ROTATING CATHODE DEPOSIT, 320 LB. (4 FT. DIAMETER, 1½ TO 2 R.P.M.)

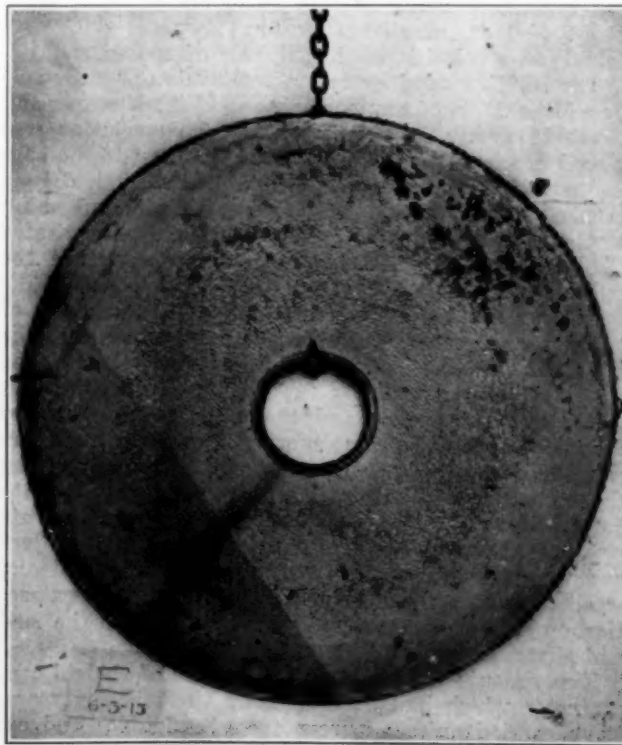


FIG. 4—VIEW OF THE REVERSE SIDE OF THE SAME ROTATING CATHODE

ments. They indicate to the writer that it would be economically profitable to ship the Butte-Superior Company's product to market from Montana as spelter rather than to Oklahoma as concentrates.

TABLE II—ANALYSES

	Bully Hill Ore	Bully Hill Zinc
Zn	29.0	99.98
Fe	15.0	.0053
Cu	2.5	.0050
Cd	0.3	.0010
Pb	tr	tr
Zn	tr	none
S	31.0	....
SiO <sub>2</sub>	6.0	....
Al <sub>2</sub> O <sub>3</sub>	8.0	....
BaSO <sub>4</sub>	3.0	....
CaO	2.5	....
MnO	0.6	....
MgO	2.8	....

Herewith are a series of photographs of zinc deposits made at Bully Hill not especially selected; also analysis of Bully Hill representative ore and analysis of electrolytic zinc therefrom.

C. A. HANSEN.

Research Laboratory,  
General Electric Co.,  
Schenectady, N. Y.

### Hydrometallurgy of Lead

To the Editor of Metallurgical & Chemical Engineering:

SIR:—In your issue of Jan. 1, under the subhead of "Lead," of an article entitled "Hydrometallurgy of Zinc and Lead in 1915," by Messrs. Lyon, Ralston and Culen, there is a description of a process for the extraction of lead from its ores by the use of a strong brine. It might appear to many that the development of this method was quite recent, while as a matter of fact it has been familiar to a number of us for some twenty-four years.

During the year 1892, while conducting my metallurgical testing laboratory in San Francisco, I developed a method for the treatment of some of the oxidized ores of the old Willow Creek Mine situated in Washoe County, Nevada. The ore contained about 10 per cent lead, nearly all of which was in the form of sulphate, the remainder being galena. The ore also contained about 10.0 oz. of silver per ton, none of which was soluble in a solution of thiosulphate of soda.

The solution used by me to treat this ore was made by adding 20 lb. of common salt and ½ lb. of copper sulphate to every 100 lb. of water. This solution was placed in small wood vats and heated almost to the boiling point, at which time the dry ore which had been crushed through a 40-mesh screen was added, forming a mixture of about 1 to 1. This mixture was agitated by the injection of steam, which also sustained the temperature.

After agitating for about one hour the mixture of solution and pulp was diluted to about 4 to 1 with the plain hot salt solution without the copper sulphate, and then agitated again for a few minutes, when the pulp was allowed to settle and the clear solution on top drawn off, at which time more plain hot salt solution was added and the operation repeated, and finally giving the settled pulp a displacement wash by gravity with hot fresh water. The hot solution drawn from the vats was passed through cement copper to recover the silver and then through scrap iron to recover the lead and small amount of copper held in solution. The extraction on this ore was over 85 per cent of both the lead and silver.

Experiments were also made on some of the old concentrates which had been lying in the mill for years. They carried quite a percentage of sulphides and arsenic. They were therefore given an oxidizing roast and then treated by the above method with an extraction of only 45 to 50 per cent of the contained lead and silver.

The largest amount of ore that I treated by this method at one time was about 1 ton, and that lot was treated in Salt Lake City in 1900 to demonstrate to a party of men the feasibility of the method for the particular ore mentioned above, all former tests having been made on samples of from 1 oz. to 500 lb.

HENRY R. ELLIS.

Salt Lake City, Utah.

### Will Silver Come Back?

To the Editor of Metallurgical & Chemical Engineering:

SIR:—An eminent European authority of international standing—Mr. Moreton Frewen—in a recent letter to the writer says:

"I anticipate that when the Bankers, after the War, have come to count its cost and the enormous mass of unconvertible paper that has been issued and most of which will be at a huge discount, they will take immediate steps to secure Open Mints and Free Exchanges for the two metals"—i.e., gold and silver.

In view of the increasing international scramble for the world's limited supply of gold (when compared with the business of the world), and the recent great flow of that metal from Europe to the United States in payment for food, raw materials and war supplies, all indications are that the European countries will, after the war, be absolutely driven by dire necessity to a greater recognition of silver as a money metal, which will have far-reaching effects on the world's trade and commerce and will enhance the market price of silver.

This will necessarily affect the United States as a great silver producer and exporter, and American trade with silver-using countries.

Unfortunately, matters of finance a little out of the usual course too often do not appeal to business men and others absorbed in their own affairs. They do not take the time to understand them and, not understanding them, conclude such matters are wrong. A proposal may be no novelty; it is only a novelty to them.

Moreover, years ago there was so much bitter controversy on the silver question that the moment a writer approaches it, even remotely, prejudice is aroused with many not fully informed and whose minds are not in possession of information on changed conditions.

Nevertheless, in view of apparently inevitable action by European countries in the not distant future, a brief résumé from an American standpoint on the subject of silver as affecting United States production and export of the metal and American trade and commerce with silver-using countries is opportune at this time.

The 1915 report of the director of the U. S. Mint contains much germane information furnishing food for thought.

### UNITED STATES LEADING SILVER PRODUCER

While the United States has long been one of the leading producers of silver, the price of the metal has been practically fixed in London.

The 1915 mint report furnishes the following information:

The production of gold and silver from the mines of the United States, from 1792 to 1914 inclusive, is stated as:

TABLE I

	1913	1914
North America:		
United States	\$40,348,100	\$40,067,700
Canada	19,041,000	15,097,300
Mexico	42,705,100	39,099,200
	\$102,094,200	\$94,264,200
Central America	1,290,000	1,336,500
South America	7,928,600	7,155,000
Europe	9,215,500	8,448,400
Australasia	10,949,800	1,946,700
Asia	3,130,400	2,998,400
Africa	637,900	570,000
Total	\$135,246,400	\$116,719,200



Gold, 175,859,429 fine ounces; value, \$3,635,331,200.

Silver, 2,158,431,200 fine ounces; *commercial* value, \$1,749,585,300.

The sources and *commercial* value of the world's production of silver for 1913 and 1914 are given as follows, at \$0.604 per ounce for 1913 and at \$0.553 per ounce for 1914:

It is obvious that North America is especially interested in the future of silver.

#### MINTS CLOSED AGAINST COINAGE OF SILVER "ON PRIVATE ACCOUNT"

Space does not admit of details of the adoption of the single gold standard by various countries.

In 1873 the U. S. Congress passed an act whereby subsidiary U. S. silver coins and a "trade dollar" of 420 grains weight (in lieu of the previous standard silver dollar) coined at the expense of the depositor, i.e., "on private account," should thereafter be a legal tender at their nominal value for any amount not exceeding \$5 in any one payment.

In 1876 Congress took from the "trade dollar" its legal-tender quality and authorized the Secretary of the Treasury to limit its coinage to its demand for exportation. The coinage of this dollar (intended for use in trade with China and Japan) practically ceased in 1878, and its further issue was prohibited in 1887.

In 1878 Congress passed the Bland-Allison act, which directed the Secretary of the Treasury to purchase, at best rates possible, silver bullion to the amount of not more than \$4,000,000 worth nor less than \$2,000,000 worth per month, to have it coined into silver dollars of full legal-tender power and to issue certificates, receivable for any Government dues, upon the deposit of those coins in the Treasury. This act brought into circulation two new elements—silver dollars (the coinage of which had been prohibited since 1873) and the silver certificates.

In 1890 Congress passed an act providing for the purchase of 4,500,000 ounces of silver bullion each month and the issue in payment therefor of Treasury notes, and repealing so much of the act of 1878 as required the monthly purchase and coinage of silver bullion.

In 1893 Congress repealed the clause in the act of 1890 directing the purchase of silver bullion and the issue of Treasury notes therefor.

In 1893, also, the mints of India, with its 259,000,000 of silver-using people, were closed to the "free coinage" (i.e., on private account) of silver rupees. In other words, private parties were no longer permitted to take their silver bullion or personal ornaments to the mints of India and (subject to a small charge for the cost of coining) receive the equivalent in silver rupees.

#### CLOSED MINTS AUTOMATICALLY DEPRECIATE SILVER

The 1915 U. S. mint report reveals the following information:

*Since 1873 the commercial ratio of silver to gold has more than doubled.*

The commercial ratio of silver to gold for 186 years, i.e., from 1687 to and including 1872, was practically steady, the minimum for any one year (1760) being 14.14 and the maximum (1812) being 16.11.

From 1873 the ratio rose from 16.16 in that year to a maximum of 39.74 (1909), in 1914 being 37.49.

*Since 1873 the gold value of an ounce of silver has declined more than 50 per cent.*

The value per ounce of silver (1000 fine) in U. S. gold coin, based on the average price of bar silver in London, for the eighty-two years, from 1833 to 1914

inclusive, was practically steady, rising from \$1.297 in 1833 to a maximum of \$1.360 in 1859, and in 1873 was \$1.29769.

From 1873 it declined to a minimum of \$0.52016 in 1909, in 1914 being \$0.55312.

*Since 1873 the bullion value of the silver dollar has declined more than 50 per cent.*

The bullion value of the silver dollar (371¼ grains of pure silver) at the annual average price of silver each year from 1837, commenced in 1837 at \$1.009, attained its maximum of \$1.052 in 1859, and declined from \$1.00368 in 1873 to a minimum of \$0.40231 in 1909, in 1914 being \$0.42810.

#### WHAT BECOMES OF SILVER MINED IN UNITED STATES

The 1915 mint report furnishes interesting information of the use of U. S. silver in coinage, arts and manufactures and exports.

For the 122 years from 1793 to 1914 inclusive, the U. S. Government coined silver of the *coinage* value of \$506,234,355, the amount for 1913 and 1914 being stated as: 1913, \$3,184,229; 1914, \$6,083,823. No standard silver dollars have been coined since 1904.

The difference between the *commercial* value and the *coinage* value of the silver coined is called "seigniorage," and is the profit of the Government.

The stock of silver coin in the United States on June 30, 1915, is estimated at \$753,701,905, and the stock of silver bullion in U. S. mints and assay offices on June 30, 1915, at \$4,337,516.

For the thirty-five years from 1880 to 1914 inclusive, the amount of silver (U. S. coin, domestic and foreign bullion and foreign coin) furnished for use in manufactures and the arts amounted to 485,500,570 fine ounces.

The exports of silver bullion (presumably *commercial* value, though not so stated) from the United States from 1900 to 1914 inclusive are as follows:

United Kingdom .....	\$640,557,856
Asia .....	98,235,551
All Other Countries.....	61,702,956
	<hr/>
	\$800,496,363

A great part of the silver exported from the United States to the United Kingdom is re-exported from London to the Orient, and the report gives the details of the enormous silver export, from 1881 to 1914 inclusive, from London to India, China and the Straits Settlements.

#### SILVER COINAGE BY FOREIGN COUNTRIES

The silver coinage of the world for 1913 and 1914 alone, when the average market price of silver per ounce was \$0.60458 for 1913 and \$0.55312 for 1914 (the *coinage* value calculated in U. S. money), was:

1913 .....	\$131,125,727
1914 .....	120,933,328

The ten leading countries (outside the United States) being as follows:

	1913	1914
Austria-Hungary .....	\$10,929,392	
China .....	15,829,272	\$49,419,143
France .....	4,179,250	
Germany .....	12,168,426	16,010,633
Great Britain .....	8,241,662	
India .....	55,551,112	17,608,768
Japan .....	2,138,127	
Netherlands .....	321,600	7,268,362
Persia .....	2,872,495	4,756,890
Russia .....	3,442,293	

For the fifteen years 1900-1914, during which the United States exported, as shown above, silver bullion to the amount of \$800,496,363, the market price of silver averaged less than 58 cents per ounce.

Foreign countries have made, in the aggregate, enor-

mous profits out of the "seigniorage" of coining cheap silver originating in the United States.

#### INDIA NOW GOLD "SINK HOLE"

The great majority of the 295,000,000 of people of India do not use banks as Americans do, from the wealthiest down to the poorest more or less hoarding their surplus coin, many people of small means having same made into bracelets, anklets, etc., for their wives, who thus become the family "safety deposits." Others hide their coin reserves, while the wealthier have secret strong rooms or receptacles for bullion and coin.

For fifty years prior to the closing in 1893 of the Indian mints to the coinage of rupees "on private account" the import of silver into India was four times that of gold, and India was known as the "sink hole" of silver, as that metal once gone into India practically never came out.

The change of standard in India in 1893 from silver to gold resulted in India's precious metal imports, from 1896 to 1910 inclusive, being in the proportion of 100 of gold against 64 of silver.

In 1910 the Indian Government imposed a 16 per cent duty on all silver bullion imported into India, resulting in increasing imports of gold (mostly for hoarding purposes) and declining imports of silver.

The annual statistics for the fiscal years 1873 to 1912 inclusive show the enormous excess of imports of gold and silver into India over the exports from India, the excess gold imports increasing at a rapid rate in recent years, from 1896 to 1914 inclusive, amounting to more than 27,000,000 ounces of gold of the value of more than \$540,000,000!

This abnormal Indian absorption and hoarding of gold has practically offset the benefit to the world's trade and commerce of the increased gold output of South Africa and elsewhere in recent years, and has materially intensified the gold shortage in Europe.

#### CHEAP SILVER ESPECIALLY BENEFITS THE ORIENT

Cheap silver especially benefits the great silver-using countries of China, India, Japan, etc., in their international trade with (and at the expense of) the gold-standard countries in Europe and the United States.

Kaiser William of Germany once referred to the Oriental nations as the "Yellow Peril." Cheap silver is developing them into a commercial and manufacturing "Yellow Peril" to the gold-standard countries of Europe and the United States.

Years ago it was predicted that, with the decline in the market price of silver, "the yellow man with the white dollar would beat the white man with the yellow dollar" in international trade and commerce. That prediction is being verified.

Cheap silver, involving fall in exchange between gold-standard countries and silver-using countries, is an increasing tariff in favor of the Asiatic producer and manufacturer, as against imports from gold-standard countries, but, unlike a tariff, Asiatic exports are not reduced, but are, so to speak, subsidized.

While India and Japan are nominally on a gold-standard basis, silver is the money metal of the great masses of the people. China is wholly on a silver basis.

Since the commencement in 1873 of the fall in the market price of silver, the rise in the rate of wages and cost of living in the great silver-using countries of the Orient has been inconsiderable.

The standard silver coins of those countries and their equivalent values in U. S. gold coin are: China, the "tael," about 55 cents; India, the "rupee," about 32 cents; Japan, the "yen," about 49 cents. Those coins have almost as great a purchasing power in the internal

trade and commerce of their respective countries to-day as they had years ago.

But in international trade between those countries and the gold-standard countries of Europe and the United States, cheap silver stimulates Asiatic factories and exports and fosters the competition of yellow labor with white in important trades—iron, coal, steel, textiles, etc.

The greater the amount of silver that Asiatic countries have had to pay for the purchase, on a gold basis, of imports from the gold-standard countries, the more the Asiatic countries were driven, in self defense, to manufacture for themselves wherever possible and cease importing to that extent.

Silver, as a mere commodity, without recognition at the mints of the world at any internationally fixed ratio with gold, naturally fluctuates in market price, and to that extent renders more difficult trade and commerce between the gold-standard countries of Europe and the United States and the populous silver-using countries of the Orient.

For instance, as the bullion price of silver falls, it becomes more difficult to continue exports to China. No merchant in China can buy exchange (in other words, buy gold) on London, Paris or New York, so that cheap silver assists Chinese mills and other manufacturing industries, protecting them from competition of imported foreign goods, which would be possible with higher-priced silver, and especially with an international-fixed ratio between silver and gold.

Cheap silver stimulates Asiatic exports to the markets of America and Europe for the simple reason that the Asiatic exporter who formerly sold his products for one British sovereign or for five U. S. gold dollars received in exchange for that sovereign or five gold dollars three "taels" only. With cheaper silver, he now receives for that British gold sovereign or five American gold dollars, not three, but eight "taels." The same general conditions prevail in India and Japan, and the great industrial development since 1873 in the silver-using countries is very largely owing to cheap silver.

With the opening of the Panama Canal and Japan's development of her mercantile marine in the Pacific, the gold-standard countries are confronted now, more than ever before, with the industrial menace of cheap silver—of "the yellow man with the white dollar."

All of which demonstrates that this country is vitally interested in any action found necessary by the European countries looking to the increased use of silver as a money metal, at some internationally fixed ratio of silver with gold, thereby permanently enhancing and steadying the future market price of silver to the great advantage of Europe and the United States, with corresponding impetus to international trade and commerce.

The consent and co-operation of the United States will be necessary to perfect any such action by the European countries.

THOMAS TONGE.

Denver, Col.

[In publishing Mr. Tonge's article we do not wish to commit this journal in any way on the political aspects of the question, but feel that the interesting and timely statistical information contained in Mr. Tonge's article merits the attention of silver producers and metallurgists in general.—Editor METALLURGICAL AND CHEMICAL ENGINEERING.]

#### Arizona Copper Strike Ended

The four months' labor strike at the Shannon Copper Company's, the Detroit Copper Company's, and the Arizona Copper Company's works in the Clifton and Morenci district in Arizona has been ended on Jan. 24.



The wages are increased. The union is not recognized. Any future differences are to be settled by conferences between company officials and employee committees.

There is to be an immediate resumption of mining, milling and smelting. The normal production is 6,000,000 lb. of copper monthly.

### Mineral and Chemical Exploration Act Passed

The House of Representatives has passed an act "to authorize exploration for and disposition of coal, phosphate, oil, gas, potassium and sodium," reported favorably by the House Committee on Public Lands.

The measure has now gone to the Senate, where it has been referred to the Committee on Public Lands of that body.

Important features of the measure as it passed the House are as follows:

The Secretary of the Interior is authorized to lease to any qualified applicant any deposits of phosphates or phosphate rock belonging to the United States, through advertisement, competitive bidding or such other methods as the secretary may by general regulations adopt. Each lease shall be for not to exceed 2560 acres of land, the land to be in compact form, the length of which shall not exceed two and one-half times its width. For the privilege of mining, royalties, to be fixed by the secretary in advance of offering the land, are to be paid, not less than 2 per centum of the gross value of the output, and an annual rental, which shall not be less than 25 cents per acre for the first year, 50 cents for the second, third, fourth and fifth years, and \$1 per acre thereafter, the rental to be credited against the royalties. Leases are to be for indeterminate periods upon condition of a minimum annual production. There is a strike clause, and there is to be a readjustment every twenty years. Lessees are to have not more than forty acres of the surface of unentered lands for prospecting.

The Secretary of the Interior is authorized to grant prospecting permits for chlorides, sulphates, carbonates, borates or nitrates of potassium or sodium, or associated similar salts, for a period of not exceeding two years. Areas are likewise limited in this case to 2560 acres. Upon discovery of valuable deposits, permittees are to be entitled to patents for 640 acres. Leases are to be permitted upon terms similar to those outlined in the case of phosphates or phosphate rock. In addition to the 640 acres, 20 acres are to be allowed for camp sites, refining works, etc.

The provisions of the act apply to deposits "owned by the United States, including those in national forests, the Grand Canyon National Monument, and the Mount Olympus Nation Monument," but excludes those in national parks, "and in lands withdrawn or reserved for military or naval purposes."

The provisions of the act as to coal specifically excludes deposits in Alaska. Common carriers are not allowed to take coal deposits larger than needed for their own purposes, and are limited to one lease for each 200 miles of line. A royalty and lease-fee system, such as is specified for phosphates and phosphate rock is provided for coal.

In the case of oil and gas, prospecting permits are provided for, upon lands "located within ten miles from any producing oil or gas well." In the territory of Alaska prospecting permits may be granted for periods not exceeding four years. Patents for leases may be granted for one-fourth of the land embraced in the prospecting permit. Timber is reserved to the United

States. Leases shall be for a period of twenty years, subject to renewal, the payment to be not less than \$1 per acre per annum. Rights-of-way through public lands for pipe lines are provided for.

The rights conferred by the act are upon "citizens of the United States, or to any association of such persons, or to any corporation organized under the laws of the United States, or of any State or territory thereof, and in the case of coal, oil, or gas, to municipalities." No corporation shall hold any interest as a stockholder of another corporation in more than one lease. No lessee shall hold more than a tenth interest in any agency engaged in the sale or resale of coal, phosphate, oil, gas, potassium or sodium, obtained from such lessee. Moneys derived are to be paid into and appropriated as a part of the Reclamation Fund.

### Hearings on Proposed Dyestuff Tariff

Hearings were held on Jan. 14 to 15, before the House of Representatives Committee on Ways and Means, for the purpose of obtaining information on the dyestuff situation in order that legislation may be passed if possible to encourage the industry in the United States. The subject of the hearing was the so-called Hill bill (H. R. 702), which would place a duty on all dyes and intermediates. Technical experts, manufacturers of dyestuffs, and representatives of dyestuff consumers were present and testified at the hearing.

About the same time as the opening of the hearings, the Bureau of Foreign and Domestic Commerce issued a report by Thomas H. Norton (Special Agent Series No. 111). In this report Dr. Norton gives the status of the dyestuff situation as in November, 1915. He states that before the war 3300 tons of dyes were made here, while now about 15,000 tons are made. A list of the industries dependent on dyestuffs is given, together with a list of the present manufacturers of intermediate and finished dyes. Dr. Norton states that the Department of State has exerted every effort for eight months to secure the free passage of German dyestuffs to our ports. No results have thus far been obtained. The Department of Commerce has also exerted every effort to alleviate the situation and is strongly in favor of protecting and fostering the American industry. The manufacture of coal tar crudes, Dr. Norton says, has assumed large proportions, but, owing to the great demand for such products in the manufacture of explosives, the dyeworks cannot get adequate supplies.

At the hearings before the Committee on Ways and Means, which is the tariff-making body of the House, the general consensus of opinion was strongly in favor of the bill. As to its effect, the general opinion seemed to be that it would not give much immediate relief except in unloading whatever supplies might be hoarded, but its future effect would be to encourage present manufacturers to increase their output and to induce new capital to enter. Some were in favor of a dumping clause, in addition to the bill to prevent unfair competition after the war. The possibility of using the dye factories for explosives was also strongly brought out, and future chemical independence and the foundation of an American organic chemical industry were other strong points presented in favor of the bill.

The first expert called by Chairman CLAUDE KITCHEN was Dr. BERNHARD C. HESSE, representing the chemical and dyestuff committee of the New York Section of the American Chemical Society. Dr. Hesse first read a letter of the committee to Hon. E. J. Hill under date of Jan. 7, 1916. (The original report of this committee, which furnished the basis for the Hill bill, was published in our issue of December, 1914, Vol. XII, page 753.)

## LETTER FROM CHEMICALS AND DYESTUFFS COMMITTEE

NEW YORK, January 7, 1916.

HON. E. J. HILL,

House Office Building, Washington, D. C.

SIR: H. R. 702 is, in part, based upon the report of the chemicals and dyestuffs committee to the New York section of the American Chemical Society appearing in the Congressional Record for December 10, 1914, copy of which is hereto attached.

The undersigned, constituting the complete membership of seven of that committee, herewith submit, at your request, their justification of—

(1) The rates proposed in that report and by you incorporated into H. R. 702, and

(2) Their expectation that as a result of such duties a complete, self-contained, and independent coal-tar chemical and dye industry will eventually result in the United States.

The professional activities of these seven men and the industrial occupations represented by them on this committee are as follows:

- (1) Manufacture of heavy chemicals.
- (2) American coal-tar dye producers.
- (3) Textile interests.
- (4) Importers of coal-tar dyes.
- (5) American producers of crude coal-tar products.
- (6) Leather and tanning interests.
- (7) Chemical expert in coal-tar dyes.

In 1882 this country possessed a coal-tar dye industry that promised to grow into something worth while. There was then a duty of 35 per cent ad valorem and 50 cents per pound specific. When this specific duty was removed in 1883, whatever we then had of a coal-tar dye industry languished and has since been practically without effect. A specific duty has since then not been levied.

In 1908 two of the largest American coal-tar dye plants then in existence (Schoellkopf, Hartford & Hanna Co., of Buffalo, and Heller & Merz Co., of Newark, N. J.) submitted to the Committee on Ways and Means under date of November 9, 1908, at the hearing of November 11, 1908 (pp. 128-130, vol. 1 of the official record of those hearings), a detailed statement as to the added protection they would require in order to compete successfully in this market against European-made dyes, but themselves using European-made intermediates. In that elaborate cost statement they showed that a proposed materials cost of 13.22 cents per pound for finished dyes as against an existing cost of 14.76 cents (i. e., a materials cost decrease of 1.54 cents per pound), together with an increase in the ad valorem rate from 30 per cent to 40 per cent, would enable them to successfully compete, although using foreign-made intermediates. At the same time and place they also showed that the corresponding materials cost for the same finished dyes per pound in Germany was 10.57 cents.

Reverting now to the tariff in effect in 1882, this committee is dependably informed that the then average import value of the great bulk—that is, from two thirds to three-fourths of all the European-made coal-tar dyes entering this country—was a little over \$1 per pound, and this notwithstanding the statement of from 50 cents to 60 cents made by Mr. John Campbell under date of July 26, 1882, at pages 154-156, volume 1, of the Report of the Tariff Commission of 1882. If this committee's information of the \$1 figure be correct, then the specific duty then in effect was essentially one-half of the fair average import value of the bulk of the dyes reaching this country from Europe.

This committee was further dependably informed that in 1914, before the outbreak of hostilities, the fair average import value of the bulk—that is, from two-thirds to three-fourths of all the dyes reaching this country from Europe—is 15 cents. If, therefore, the specific duty of 7½ cents be now added to the prevailing ad valorem of 30 per cent, the tariff conditions of 1882, under which we did have something in the way of coal-tar dye industry, would be substantially reproduced, and under those conditions it is not unreasonable to expect that the industry would again flourish in this country.

In all of the tariff legislation heretofore enacted some of the coal-tar dyes were put upon the free list; also the intermediates have been more or less (principally more) upon the free list. In other words, the protection afforded to the coal-tar dye industry has never been such as to cover the entire industry, but only segregated parts thereof. Each and all of these tariff enactments failed to provide for a co-ordinated protection of the making of intermediates and of the production of the finished dyes therefrom all in this country.

Therefore, this committee recommended that this isolated and "spotty" protection be removed and all dyestuffs, by

whatever name known and produced in whole or in part from materials obtained or obtainable from coal tar, should be treated alike for tariff purposes; all should be taxed 30 per cent ad valorem plus 7½ cents per pound specific.

In general, the German 1913 export price of intermediates is about one-half that of finished dyes. Therefore, this committee compensated the specific on finished dyes to the intermediates by adding a specific duty of 3.75 cents per pound on all intermediates. This committee suggested a 15 per cent ad valorem duty on intermediates as against 30 per cent ad valorem on finished dyes because, compared with the finished dyes, with the intermediates being made in larger units and larger amounts, the handling costs in manufacturing intermediates in the factory are less than the handling costs for finished dyes.

Returning now to the statement of Messrs. Schoellkopf and of Messrs. Heller & Merz above referred to, the added protection due to the there proposed increased ad valorem would amount to 1.5 cents on dyes of an average value of 15 cents entering this country. Adding this 1.5 cents to the 1.54 cents above shown gives, as a total, an added 3.04 cents protection per pound on dyes of the above-stated fair average import value.

As a test case of the net effect of this schedule of rates upon the production of the cheapest dyes, this committee further had the benefit of the following calculations based upon the assumptions now to be given:

The dye known as Orange II is probably the type of the cheapest of the dyes that are imported into this country. It is made by assembling two intermediates known, respectively, as sulfanilic acid and betanaphthol. In general, 173 pounds of sulfanilic acid and 144 pounds of betanaphthol will yield 350 pounds of the commercial dye in its highest commercial concentration. There were four cases assumed with regard to respective import values, as follows:

Case	Orange II	Sulfanilic Acid	Betanaphthol
	Cents	Cents	Cents
I.....	8	4	6
II.....	8	6	8
III.....	12	8	9
IV.....	12	4	6

The calculated respective added advantages for 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, and 10 cents specific for the dyes, and half of each for intermediates with an ad valorem of 30 per cent and 15 per cent, respectively, in cents per pound of Orange II, due to this schedule of rates, would therefore be as follows:

Case	6 Cents	6.5 Cents	7 Cents	7.5 Cents	8 Cents	8.5 Cents	9 Cents	9.5 Cents	10 Cents
I.....	2.61	2.88	3.16	3.43	3.70	3.98	4.25	4.52	4.80
II.....	2.34	2.61	2.89	3.16	3.43	3.71	3.98	4.25	4.53
III.....	2.13	2.40	2.68	2.95	3.22	3.50	3.77	4.04	4.32
IV.....	2.62	2.99	3.17	3.44	3.71	3.99	4.26	4.53	4.81

From this tabulation it is clear that 7.5 cents is the lowest specific rate that gives a practically 3 cents added protection per pound of this cheap dye under this variety of price circumstances and combinations.

It is therefore clear that the rates that this committee suggested meet the following three conditions:

(1) Recreate the tariff conditions of 1882 to conform as nearly as possible to the altered conditions of 1914.

(2) Give the industry that makes dyes from intermediates the added assistance that in 1908 it showed to be necessary for its continuance in business.

(3) Protect the domestic intermediates maker.

There is also the added advantage to the dye-making industry that all of the coal-tar dyes are dutiable and none are free and that all intermediates are dutiable and none are free.

That the committee's assumption that 15 cents represents the fair average import value of the bulk of the dyes reaching this country in 1914 is reasonably near the truth is shown further by the average materials and labor costs given in the statement of Messrs. Schoellkopf, Hartford & Hanna Co., and of Messrs. Heller & Merz of 1908 just referred to. The combined labor and materials costs in Germany of the 3,000,000 pounds of dyes there referred to is 12.62 cents per pound. Our present consumption of dyes is between 50,000,000 and 60,000,000 pounds per year.

In order to visualize the effect of these proposed rates



upon intermediates and dyestuffs and the total protection afforded, the following table is submitted:

PROTECTION AFFORDED UNDER PROPOSED RATES

Cents per Pound	Specific	Ad Valorem	Total Protection		Cents per Pound	Specific	Ad Valorem	Total Protection	
INTERMEDIATES	Cents	Cents	Cents	Per ct.	FINISHED DYES—cont'd	Cents	Cents	Cents	Per ct.
4.....	3.75	0.60	4.35	109	10.....	7.5	3.0	10.5	105
5.....	3.75	0.75	4.50	90	11.....	7.5	3.3	10.8	98
6.....	3.75	0.90	4.65	76	12.....	7.5	3.6	11.1	93
7.....	3.75	1.05	4.80	69	13.....	7.5	3.9	11.4	88
9.....	3.75	1.35	5.10	57	14.....	7.5	4.2	11.7	83
10.....	3.75	1.50	5.25	53	15.....	7.5	4.5	12.0	80
11.....	3.75	1.65	5.40	49	16.....	7.5	4.8	12.3	77
12.....	3.75	1.80	5.55	46	17.....	7.5	5.1	12.6	74
13.....	3.75	1.95	5.70	44	18.....	7.5	5.4	12.9	72
14.....	3.75	2.10	5.85	42	19.....	7.5	5.7	13.2	69
15.....	3.75	2.25	6.00	40	20.....	7.5	6.0	13.5	67
16.....	3.75	2.40	6.15	38	21.....	7.5	6.3	13.8	66
17.....	3.75	2.55	6.30	37	22.....	7.5	6.6	14.1	64
18.....	3.75	2.70	6.45	36	23.....	7.5	6.9	14.4	63
19.....	3.75	2.85	6.60	35	24.....	7.5	7.2	14.7	61
20.....	3.75	3.00	6.75	34	25.....	7.5	7.5	15.0	60
25.....	3.75	3.75	7.50	30	50.....	7.5	15.0	22.5	45
					75.....	7.5	22.5	30.0	40
					100.....	7.5	30.0	37.5	37.5
					150.....	7.5	45.0	52.5	35
FINISHED DYES									
8.....	7.5	2.4	9.9	124					
9.....	7.5	2.7	10.2	113					

In 1913 the average export value out of Germany of intermediates was 10.07 cents per pound and of finished dyes 21.53 cents per pound. Therefore, these proposed rates give a total protection of 53 per cent to this average value of intermediates and of 65 per cent to this average value of finished dyes, and, furthermore, conform very closely to the tariff conditions in 1882 and satisfy the 1908 requirements of the United States dye makers mentioned; and, in addition, protect the entire class of coal-tar dyes and their respective intermediates and give the prospective American intermediate maker a protection which he has hitherto never enjoyed.

This committee further believes that with this protection on the cheaper dyes the domestic manufacture of the more expensive varieties of dyes, of pharmaceuticals, of medicines, and of explosives will follow almost as a matter of course.

In order that there may be given as little opportunity as possible for evasion of the duties contemplated to be imposed by the report of this committee, this committee now respectfully suggests to you that H. R. 702 further contain a definition of what is to be a coal-tar dye for the purposes of this act, so that such things which under our present adjudications are not coal-tar dyes and are not coal-tar dye intermediates will be obliged to pay the duty of coal-tar dyes.

The materials we have in mind are the dye bases known as magenta base, Victoria blue base, Victoria green base, Bismarck brown base, auramine base, crystal violet base, methyl violet base, rhodamine base, chrysoidine base, and the like, which are imported in that condition and merely require the addition of a small amount of muriatic acid thereto to convert them into the commercial forms of dyes. In the form of bases, they are neither dyes nor intermediates and they pay 20 per cent as coal-tar preparations; they are not dealt in on the European markets; they have no fixed market value; the importation value into the United States can be whatever the exporter chooses. In this connection it will be necessary to look into the language employed by the court in the decision reported under Treasury decision 34,400 in volume 26 for January to June, 1914, and 5 Customs Court of Appeals. Furthermore, the language used in the cases cited in Treasury decision 28,003 with regard to bromofluorescein acid should be consulted so as to prevent evasion along the line of those products which are dye acids and need merely the addition of a small amount of soda ash to convert them into commercial dye forms. It would not do to place these rates upon coal-tar dyes and then enable foreigners to ship into this country things that are not dyes and not intermediates under our present adjudications and which merely need the addition of a negligible amount of muriatic or other acid or of soda ash or of similar material to convert them into the real dyes of our adjudications. It is obvious that if any such loophole were permitted to stand the result expected of those rates would not take place—i. e., a complete, self-contained and independent coal-tar, chemical, and dye industry within the borders of the United States.

This committee further suggests that in placing natural indigo on the free list, the wording selected be such as positively to exclude indigo not derived from vegetable sources from that free list.

From the point of view that the protective duty contemplated to be added by these proposed rates will reappear in whole or in part in the form of a direct addition to the normal cost of dyestuffs, it is clear that those users of dyestuffs that have in whole or in part hitherto enjoyed the free list will bear the greater relative proportion of such putative increase. Whether such addition will actually take place or not this committee expresses no opinion; it merely states the maximum that can reasonably be expected in the way of increased cost to the users of dyes in this country. In other words, as we stated in our above report, namely: It will, therefore, be necessary to determine carefully if the advantages to be gained are equal to the price to be paid.

The committee herewith unanimously reaffirms its belief that the rates proposed in its report of November, 1914, above referred to, are the lowest at which a self-contained, complete, and independent coal-tar, chemical, and dye industry can be created in this country, and which at the same time offer a legitimate incentive to legitimate capital for a legitimate effort to produce these goods in this country. Whether capital will avail itself of this advantage or not this committee expresses no opinion.

As to this schedule of rates proposed—

(1) It is the probable lowest schedule that will induce complete, self-contained, and independent manufacture within the United States.

(2) It meets and very closely duplicates the tariff conditions existing in 1882 when we did have something of an industry of this kind.

(3) It meets the requirements set forth in 1908 as necessary to maintain a dye industry in this country, which dye industry then operated with foreign-made intermediates.

(4) It provides at the same time a suitable protection to the making of intermediates within the United States.

(5) It puts all dyes of coal-tar origin upon one and the same level for tariff purposes and also puts all such intermediates upon one and the same level for tariff purposes.

(6) It gives a protection of 53 per cent on the average value of all intermediates and of 65 per cent on the average value of all finished dyes, such average values being average export values out of Germany for 1913.

Respectfully submitted.

BERNHARD C. HESSE, Chairman, J. B. F. HERRESHOFF, I. F. STONE, J. MERRITT MATTHEWS, H. A. METZ, D. W. JAYNE, ALLEN ROGERS.

Dr. Hesse said in the hearings on Jan. 14 that the rates proposed reproduce as near as possible the relative conditions existing in 1882, when this country did have something of an industry. They reproduce also, as nearly as possible, the added protection asked for in 1908, and a complete protection for manufacture of intermediates has been added. Furthermore, it is proposed to remove from the free list all products of this kind; in other words, protection is put on everything. In that way, by giving added protection to the manufacturer of intermediates in this country, and at the same time giving the manufacturer of dyestuffs, who employs these intermediates, the protection that he asked for in 1908, and reproducing at the same time the conditions of 1882, when this country did have something of an industry, are the reasons why it is expected—and believed that the expectation is justified—that if those conditions are reproduced in 1915 or thereabouts that this country will then have something of an industry.

Dr. Hesse said there were plenty of coal-tar crudes available before the war. He said it had been understood that Schoellkopf, Hartford, and Hanna of Buffalo had not been very successful since 1882. He said that when intermediates come in free this country only has an assembling industry, and when these are shut off the industry is choked. In regard to natural indigo being placed on the free list, Dr. Hesse said 95 per cent of the indigo used was synthetic, so this made little difference. He did not think the German industry was protected to any great extent by patents, as 99 out of 100 patents are "misfires."

Dr. Hesse said the dye users should co-operate with the manufacturers by telling them what they want and in what amounts. He said the difference in the cost of labor was one factor in determining a tariff.

Another factor discussed was the relation between explosives and dye manufactures. Dr. Hesse said: "We are rapidly approaching a position where we are independent of any foreign country except Chile for any materials that we may want for defense." If we had a complete coal-tar dye industry we would have an equipment and workmen which could quickly be shifted to making explosives. However, the two industries are not inextricably joined, as one could easily exist without the other. At present Dr. Hesse said our production of coal-tar products was going mostly for explosives. The output is greater than we would need for dyes. He said substantial relief could not be expected in from six months to three years.

A statement was read to the committee from the Monsanto Chemical Works, St. Louis, Mo., in which they stated that they had previously imported raw materials for their products, which are fine and medicinal chemicals. They have expended \$200,000 on new equipment to manufacture their own raw materials and want protection. They state that they will be supplying their products at reasonable prices in from thirty to sixty days.

Dr. J. MERRITT MATTHEWS, consulting engineer, of New York City, was next called. Dr. Matthews is a member of the committee of the American Chemical Society, of which Dr. Hesse is chairman, and said that he had come into pretty intimate contact with quite a number of textile organizations, and they have all evinced a strong desire to see a dyestuff industry established in this country, looking toward it as a method of insurance that present conditions shall not recur. He always understood production costs in Europe were far less than ours, but he could not state exact comparative costs. It is not a question of increasing costs to the textile men; it is a question of saying whether they shall continue in business. One per cent is a high average limit for cost of dye in the finished product. The addition in the price of goods is high now on account of abnormal price of dyes, but in normal times the increased cost with the proposed tariff on would be very small. One cent would cover the increase on a suit of overalls.

To make finished dyes requires an organization, and there is considerable inertia to overcome. People are loth to go into it unless they have assurance of protection. The bill would not prohibit imports, as there would be a demand for many dyestuffs not developed in this country. We should receive a practical benefit in twelve months, and some dyes could be made in three months. Others would take years.

Ability to make explosives is also an important point, and should be the first consideration. Great Britain has subsidized her industry with Government participation, under the name of British Dyes, Ltd. They have passed prohibitive laws dealing with Germany. Russia has done the same. Of course, resentment may have played a part in their action.

Dyes should be lower in price after a time through competition. It is not likely at present that the textile industries would ask for an increased tariff on textiles if a dyestuff tariff would be enacted. The levying of the tax would not produce the results it would have produced in 1908, when so many mills opposed the increase tariff on dyes. It is absolutely essential that intermediates be given protection to have a complete industry, and since the value of the intermediates is, roughly speaking, one-half the value of the dyestuffs, the committee concluded that the intermediates should bear one-half the ad valorem duty and one-half the specific duty of the finished dyestuffs.

Mr. L. A. AULT of Ault & Wiborg Co., Cincinnati,

Ohio, manufacturers of printing inks, said they were now making their own intermediates and some dyes for their own use, otherwise their factory would have been closed during the past four months on many essential colors. He was strongly in favor of the bill, and cited as an example the tin plate industry, which was fostered by the McKinley bill, while tin plate is now selling at much lower price than when the law was enacted, and this country is an exporter in the bargain. All colored printing stops when the dyes are shut off. Newspaper inks are, however, not affected.

Mr. HERMAN A. METZ, importer, manufacturer and consumer of dyes and also a member of Dr. Hesse's committee, said in part: The increased cost of dyes if made here would not affect consumers. Labor is not such an important item. The plant with which he is connected in Germany is running with two-thirds of its force. The 30 per cent duty covers the difference in labor costs. His company, the Consolidated Color & Chemical Co. of Newark, has expanded to three times its former size, and he is now making his own intermediates. The rates proposed are the minimum which are necessary. Benzol and acids at present are hard to obtain, due to munition manufacture. The bill will not help during the war as raw material cannot be obtained fast enough. This country will not make all colors, as the very fine colors will still be imported.

Mr. HERBERT H. DOW of the Dow Chemical Co., Midland, Mich., said that his company went ahead and took the chance, and is now erecting a plant with a capacity of 1000 lb. of dry indigo per day. He expects to have it finished in July. He is not confident of competing with the Germans until the tricks of the trade are learned. He thinks the tariff could be removed after the industry is established if dumping is prevented.

Prof. CHARLES H. HERTY, president of the American Chemical Society, said in part that he does not consider this question that is before us now as the usual tariff problem, but the mills of this country are suffering and a crisis is here. The organic industries are lacking greatly in this country in the way of chemical industries. It is impossible to develop all lines at once, so that the by-products of one industry could be used in another, as Germany has succeeded in doing in fifty years of experience. Apparatus is hard to get in view of the present shortage of steel, and methods given in the literature are often purposely deceiving.

Five or six years ought to be enough to get the majority of the manufacturers in good shape. As a Democrat he wrestled with this question a long time, and is now convinced that if this country is to have an industry it must have a protective tariff. He thinks one thing which has been shown up through the European war, and which is clear now to all, is the value of chemistry to a nation. His hope and desire to see the dyestuff industry proper is because it is going to stimulate all kinds of chemical work; it is going to put chemistry on a higher plane in this nation. It is to the interest of the cotton-goods men who look forward to export trade to have American-made dyes rather than get them from competitors in the cotton-goods business. There are a great many things brewing in this country ready to get started, and everyone is looking to Congress. There need not be unfair prices as a result of this tariff as German competition and the Sherman anti-trust law ought to prevent that.

Mr. J. F. SCHOELLKOPF, president of Schoellkopf Aniline & Chemical Works, Buffalo, N. Y., said in part: The rates proposed may be sufficient as the manufacturer of intermediates may be able to sell his products without being obliged to take full advantage of the proposed duty, but if a rapid expansion is desired the



rates should be increased. In addition to an adequate tariff on all coal-tar products and colors, some effective anti-dumping legislation will have to be enacted. Without such a clause, nothing can prevent the crushing of the domestic industry if the foreign conventions so decrees. Another question to be considered is whether or not the Government should assume some sort of supervision.

His company is making nearly all its own intermediates and the labor cost is about 40 per cent. They could make explosives in a week and go back to colors in a week. Only the intermediate plants are used in making explosives. They have increased their capacity 125 per cent since the war. He does not think anything like 15,000 tons of colors are now being produced. About 5000 tons is nearer the right amount. They have had experiences with unfair competition in the way of underselling. Dyes have been sold here for 18 cents, paying 30 per cent duty, when they were selling in Germany for 22 cents. His company expects to be making 7000 tons per year within the next two months, and could soon double that output if machinery could be obtained. The plant is already built for increasing to 7000 tons per year. They did it because they were enabled to make products from their raw materials and products for which their intermediates could be used. They tried to make enough to pay for the plant and make a profit besides. With increased production they ought to be in a better position to compete.

Mr. Schoellkopf submitted tables which he had previously submitted in 1908 and 1913, showing the cost of a complete plant and production costs for an output of 3,000,000 lb. of dyes per year. The production cost was figured as 1.34 times the cost in Germany under the proposed tariff and 1.44 times under the present tariff.

Dr. WM. BECKERS, president of W. Beckers Aniline & Chemical Works (Inc.), Brooklyn, N. Y., said that this country may even lose the 15 per cent of business it had before the war if the tariff is not revised. Alizarin dyes which come in free, constitute one-third of the money value of the entire importation. It is not fair to leave them untaxed. They are mostly the finer colors used on expensive material bought by well-to-do people who can better stand the increased cost than those using goods made with cheaper dyes. American consumers have not enjoyed the benefit of the duty-free colors as the foreign conventions have placed their prices as they wished. Revision must be done in a thorough and correct way so that alongside of the other already highly developed industries of the United States a "modern organic chemical industry" can be substantially and intelligently built up as a whole on American soil. The German Government will assist the dye-makers in preventing any foreign industry to develop. The rates proposed could be increased, but they may be sufficient. They surely will not create a hot-house industry. If the bill is passed he will have four or five millions at his disposal instead of one-quarter of a million.

Mr. EDWARD MOIR, president of the Carded Woolen Association, said that the increased cost on a suit of clothes would only be two-thirds of a cent.

Mr. H. B. THOMPSON of the United States Finishing Co., New York City, said the dyeing cost in cotton goods is only 0.15 to 0.18 cent and the increase would be infinitesimal. An advance of 5 cents in the price of indigo would raise the cost of dyeing cotton goods  $\frac{1}{4}$  cent on a 3-yard drill and  $\frac{1}{10}$  cent on 7-yard 64-square calico. Eighty per cent of the New England trade favor the bill. As to entering into contracts with dye-makers for dyestuffs to help foster the industry, that is not practical on account of the changing styles.

Much more testimony was given of the present shortage in clothing, the effect of the shortage of dyes reaching way back to the cotton planter and sheep raiser, and various figures of cost were given as to increases which would result in the cost of goods. For the most part the opinion was that the increased cost would be slight, and in most cases would be absorbed before it got to the consumer. Some were skeptical as to whether any immediate relief would result, but all favored the bill as beneficial for the future. Among those giving further testimony were the following: Mr. Ludwig Stein, chairman of dyestuffs committee of National Association of Clothiers; Mr. George W. Wilkie of R. H. Comey & Co., New York; Mr. J. K. Milliken, representing the National Association of Cotton Finishers; Mr. Frederick E. Kip, president Saltson Textile Manufacturing Co.; Mr. W. D. Livermore, chief chemist American Woolen Co.; Mr. John Alden of Pacific Mills; Mr. Chas. L. Auger, president National Silk Buying Co., Paterson, N. J.; Mr. Horace B. Cheney of Cheney Bros.; Mr. John W. Snowden, representing the Upholsterers of Philadelphia; Mr. D. F. Waters, president Master Dyers' Association; Mr. Jos. E. Ralph, director Bureau of Engraving and Printing. Many letters were presented by Congressmen from the various manufacturing districts favoring the bill. The hearings adjourned at 8 p. m. on Jan. 15.

### Congress Likely to Create a Tariff Commission

President Wilson is understood to have reached a decision to ask Congress to create a tariff commission, and it is said in Washington that it is more than likely that he will outline his views on the subject at the coming convention of the Chamber of Commerce of the United States, when he will speak before that body, the night of Feb. 10.

Such a proposal is likely to receive the approval of Congress, it is said in Washington, as many members of both political parties are in favor of such a commission. A place was made on the Ways and Means Committee of the House, the tariff body of the House, for Representative Longworth, when he returned to Congress, and almost his first act was to introduce a bill providing for such a commission. It is understood he was encouraged to do so by Democratic members, Mr. Longworth being a Republican.

President Wilson until recently believed, it is understood, that the Federal Trade Commission has the powers of a Tariff Commission, but he is now said to have come to the conclusion that the powers of that body are entirely too limited to meet the demands of the business world for a real tariff commission. The President will propose, it is said, a broad-gaged commission, with full power to treat the tariff in a scientific manner, and he may recommend that the commission be bi-partisan. The President, in common with other economists, it is said in Washington, has given consideration to the situation which will follow the European war, and has been urged to take measures which will prevent the "dumping" of foreign goods on the United States market when the war ends.

The bill of Representative Longworth, which may become the basis for debate and action, provides for a commission of five members appointed by the President, and holding terms of two, three, four, five and six years respectively, the term of each to be designated by the President but their successors are to be appointed for six years each. Under this bill the President would designate the chairman. Any member could, after a

hearing, be removed by the President for inefficiency, neglect or malfeasance. Not more than three members could be of the same political party. Votes would be by quorum. The chairman would receive \$7,500 a year and the other members \$7,000 a year. Rather large powers, under the bill, are granted for secretarial and other help, the latter assistance being mentioned in this way: "Such other employees as it may find necessary to the performance of its duties." The office of the commission would be in Washington, but it would have authority as a body or by one or more of its members "to conduct investigations at any other place or places, either in the United States or foreign countries." Expenses are allowed both for the commission and its employees and witnesses. The duties of the commission are thus defined under this bill:

"To investigate the cost of production of all articles which by any act of Congress now in force or hereafter enacted are made the subject of tariff legislation, with special reference to the prices paid domestic and foreign labor and the prices paid for raw materials, whether domestic or imported, entering into manufactured articles, producers' prices and retail prices of commodities, whether domestic or imported, the condition of domestic and foreign markets affecting the American products, including detailed information with respect thereto, together with all other facts which may be necessary or convenient in fixing import duties or in aiding the President and other officers of the government in the administration of the custom laws and such commission shall also make investigation of any subject whenever directed by either House of Congress."

The commission would make reports either to the President or Congress as they might direct. Power to require the production of books and papers of manufacturers, etc., is given. The bill prohibits the making public of information which would be of value to business competitors.

### Electrochemical Industries as Affected by the War

#### Program of New York Section Meeting of the American Electrochemical Society

The program of the meeting of the New York Section of the American Electrochemical Society, to be held at the Chemists' Club on Feb. 11, is particularly interesting and timely, as the subject will be "The Electrochemical Industries as Affected by the War." This will be a joint meeting with the New York sections of the American Chemical Society and the Society of Chemical Industry. The speakers will be:

- Lawrence Addicks, on electrochemical war supplies.
- W. S. Landis, on air saltpeter.
- E. D. Ardery, on hydrogen for military purposes.
- Albert H. Hooker, on new war products.
- William M. Grosvenor, on metallic magnesium.
- G. Ornstein, on liquid chlorine.
- George W. Sargent, on electric steel.

The date for the annual spring meeting of the American Electrochemical Society is April 27, 28, 29, and the place is Washington, D. C.

### Program of 112th Meeting of American Institute of Mining Engineers

Arrangements for the annual meeting of the American Institute of Mining Engineers to be held in New York City from Feb. 14 to 17 have been completed, and everything points to a very interesting and enjoyable meeting. Headquarters will be at the Engineering Societies Building, 29 West Thirty-ninth Street, New York City.

Monday night, Feb. 14, will be college night, Tuesday night the smoker, Wednesday night the annual banquet at the Hotel Astor, followed by dancing, and Thursday will be devoted to an all-day excursion.

The technical program contains papers of great interest in the various sections. The meetings of the different sections are as follows:

Monday, Feb. 14: 10 a. m., session on petroleum and gas; 2 p. m., session on coal and coke; 2 p. m., session on geology.

Tuesday, Feb. 15: 10 a. m., business meeting and technical session; 2 p. m., technical session.

Wednesday, Feb. 16: 10 a. m., session on iron and steel; 10 a. m., session on precious and base metals; 2 p. m., session on iron and steel.

### Resolution of the American Institute of Mining Engineers on the Chihuahua Murder

The following resolution was passed at the meeting of the Board of Directors of the American Institute of Mining Engineers on Jan. 21, 1916:

*Resolved*, That this Board has learned with indignation and sorrow of the unprovoked and brutal murder of eighteen American citizens on Jan. 10, in the State of Chihuahua, Mexico, and laments especially the death of Messrs. C. R. Watson, C. A. Pringle, H. C. Hase and W. J. Wallace, who were members of the American Institute of Mining Engineers. As these men and their companions were engaged in the lawful prosecution of their work, we trust that nothing will be allowed to prevent or delay appropriate action by our Government concerning the outrage by which they lost their lives.

*Resolved*, That the sincere sympathy of this Board and of all the members of the Institute is extended to the families and friends of Messrs. C. R. Watson, C. A. Pringle, H. C. Hase and W. J. Wallace.

*And be it further resolved*, that a copy of this resolution be sent to the Secretary of State of the United States, be published in the Institute's Bulletin, in the press, and be sent to the families of the deceased members.

### Annual Meeting of the American Paper and Pulp Association

The American Paper and Pulp Association will meet in annual convention at the Waldorf-Astoria Hotel on Wednesday and Thursday, Feb. 16 and 17, 1916.

The entire day on Thursday will be given over to the Technical Section, a special meeting being held in the forenoon and a general meeting in the afternoon. Committee reports will be presented at the forenoon session, the following subjects receiving consideration: Soda pulp and recovery processes, Martin L. Griffin, chairman; Sulphate pulp and kraft paper, Otto Kress, chairman; Mechanical pulp and improvements in grinding, D. L. Bellinger, chairman; Sulphite pulp and processes, Robert B. Wolf, chairman; Reports on methods of testing materials used in the manufacture of paper, H. P. Carruth, chairman.

At the afternoon session the typical apparatus used in the manufacture of pulp and paper will be exhibited and their operation demonstrated. Special forms of barkers for pulpwood will be shown in this way and new methods of drying paper will be shown. It is intended to open the afternoon session to all interested in the pulp and paper industry irrespective of membership, and a large attendance is expected.



Headquarters for the Technical Section will be established at the Waldorf-Astoria Hotel, in charge of Thomas J. Keenan, secretary. The officers of the Technical Section of the American Paper and Pulp Association and the standing committees are:

Executive Committee—Henry E. Fletcher, chairman, Fletcher Paper Company, Alpena, Mich.; W. G. MacNaughton, Nekoosa-Edwards Paper Company, Port Edwards, Wis.; Ernst Mahler, Kimberly-Clark Company, Neenah, Wis.; Charles F. Rhodes, Bureau of Tests, International Paper Company, Glens Falls, N. Y.; Henry F. Obermanns, Hammermill Paper Company, Erie, Pa.

Publication Committee—Charles F. Rhodes, Bureau of Tests, International Paper Company, Glens Falls, N. Y.; Henry F. Obermanns, Erie, Pa.; Thomas J. Keenan, New York.

Soda Pulp Committee—Martin L. Griffin, chairman, Oxford Paper Company, Rumford, Me.; Sidney D. Wells, Madison, Wis.; Edwin Sutermeister, Westbrook, Me.

Sulphate Pulp Committee—Otto Kress, chairman, Forest Products Laboratory, Madison, Wis.; Joseph E. Hedin, Wilmington, Del.; George S. Holmes, Orange, Texas.

Sulphite Pulp Committee—Robert B. Wolf, chairman, Burgess Sulphite Fibre Company, Berlin, N. H.; Fred C. Clarke, Washington, D. C.; C. C. Heritage, Port Edwards, Wis.

Standard Methods of Testing Materials Used in the Manufacture of Paper Committee—H. P. Carruth, chairman, American Writing Paper Company, Holyoke, Mass.; Raymond C. Hatch, Holyoke, Mass.; Max Cline, Glens Falls, N. Y.

Groundwood Committee—D. L. Bellinger, chairman, Finch, Pruyn & Company, Glens Falls, N. Y. Associates not yet named.

## The Western Metallurgical Field

### The Extension of Flotation

Of all the work that has been done with the flotation process, we have heard the least about its application to ores of metallic copper. Such ores, of course, are limited in distribution, being practically confined to the northern peninsula of Michigan. Nevertheless the recovery of finely divided metal is quite as much of a problem there as the slime problem is anywhere, and it is reasonable to presume that flotation should offer some advantages over present methods. This subject has been under investigation by the metallurgical department of the Michigan College of Mines, testing ore from two new properties. Flotation is found to give a much better extraction than ordinary gravity methods, but up to the present the concentrates produced are not sufficiently high grade to be handled in the type of smelting equipment usually found in Michigan. If flotation is to be applied with any degree of success, means must be found for producing a better grade of concentrate, or smelting methods must be revised. Both these suggestions are feasible, but in all probability the most advisable thing to do would be to improve the concentrates to meet the smelting conditions, since the latter are peculiarly adapted to the product of Michigan copper mills.

Progress with flotation is being made in the Cripple Creek district, where several companies have been making investigations for some months past. The Portland has definitely decided on the Callow pneumatic process, and is operating some machines in the old Stratton's Independence mill, which it purchased some time ago. It is likely that the Portland people will put this mill on a custom basis and handle ores from different parts of the district, as the plant is favorably situated for such work. Another concern that has been making extensive tests is the Vindicator, and there is a possibility that a large mill may be built for the treatment of low and medium-grade mine and dump ore.

The successful application of flotation to Cripple Creek ores appears to have been no simple matter, and several failures have been reported by individuals called upon to make tests. Those who have pursued their experiments further, however, have apparently succeeded where others failed. One essential to success seems to be the use of an unusually large quantity of oil, up to 6 lb. per ton. Such a quantity would entail considerable expense were it not for the fact that very cheap oils seem to be adapted to this work. It is in-

teresting to speculate on the future of flotation in Cripple Creek, and its effect on cyanidation. Flotation plus smelting may prove more economical than cyanidation of low-grade ores; or the cyanidation of flotation concentrates may be developed to a point where, by reason of the cheapness of flotation and the comparatively small quantity of high-grade concentrate to be cyanided, a much larger tonnage of ore may be treated in the district. Of course, it is impossible to say at this time what the developments may be, but there is a possibility that they may affect the status of present practice in the district, as well as the former strategic position of the mills treating high-grade ore at Colorado City.

Unusual conditions are being encountered in applying flotation to different ores. In the case of a certain zinc ore it was impossible to apply the process satisfactorily until copper sulphate was added to the water. In another instance, tests on a zinc ore gave satisfactory results at the testing laboratory in the city, but when the process was tried at the mill in the mountains the results were negative. Examination of the mountain water proved it to be almost free from salts; and suspecting that this might be the source of trouble, the metallurgist added mineral salts of various kinds to the water and accomplished that the results of test work were duplicated at the mill. Incidents like these give food for thought in regard to the theories of flotation, and lend weight to the arguments in favor of an electrical theory.

### Tests on a Washington Complex Low-Grade Silver Ore

The department of mining engineering of the State College of Washington, under the direction of Prof. F. A. Thomson, has been conducting a research on the metallurgy of certain complex low-grade silver ores of Okanogan, Wash.<sup>1</sup> Some of the ores in this district consist mainly of pyrite, sphalerite, galena and tetrahedrite in a gangue of bluish-white quartz. The analysis of one of the ores is as follows:

	Per Cent
Copper .....	1.55
Lead .....	3.70
Zinc .....	4.8
Iron .....	6.25
Antimony .....	3.3
Lime .....	1.05
Sulphur .....	6.80
Silica .....	72.01
Alumina .....	0.7
Silver, oz. per ton .....	26.0

Assays of the segregated minerals of the ore show the gold to be contained in the galena and tetrahedrite. Silver is more widely distributed, but is mainly concentrated in the tetrahedrite. The results are shown below:

Mineral	Gold, Oz. per Ton	Silver, Oz. per Ton
Quartz .....	None	None
Pyrite .....	0.02	26.4
Sphalerite .....	None	29.5
Galena .....	0.16	71.1
Tetrahedrite (gray copper) .....	0.12	347.6

This ore was tested both by leaching and concentration; cyanidation and hyposulphite treatment being given under the first method, and gravity concentration and flotation under the second.

**Cyanidation.**—Treatment of the raw ore proved impracticable, yielding only 50 per cent extraction, with excessive cyanide consumption. Little or no improvement was gained by preliminary treatment with caustic alkali and metallic aluminium, as practiced at Cobalt. Chloridizing roasting followed by cyanidation gave an extraction of 65 per cent, the loss being 15 per cent in roasting and 20 per cent in the tailing. Sulphatizing roasting followed by water wash to remove soluble cop-

<sup>1</sup>Bulletin 101.

per proved entirely unsuitable as a preliminary treatment. The best result was obtained by a light, thirty-minute chloridizing roast, water wash and cyanidation. This gave a total extraction of 88 per cent, the loss being 7 per cent in roasting and 5 per cent in cyaniding. The extraction of copper by the water wash was above 80 per cent.

**Hyposulphite Treatment.**—Oxychloridizing roast followed by water wash and leaching with sodium hyposulphite gave a silver extraction of about 70 per cent. Copper extraction by water wash was about 80 per cent.

**Concentration Tests.**—Treatment of each screen size in glass sorting column yielded an extraction of 70 per cent; ratio 10:1. Cyanidation of the tailing recovered an additional 18 per cent, making a total recovery of 88 per cent by the combined treatment. Straight concentration on a Wilfley table, with ore crushed to 40-mesh, gave a recovery of 80 per cent; ratio 4:1. A combination treatment was given by tabling the — 40 + 100 grade and floating the — 100. The tabling gave a recovery of 80 per cent with a ratio of  $4\frac{1}{2}$ :1; and flotation with eucalyptus oil in acid solution gave an extraction of 73 per cent at a ratio of  $3\frac{1}{2}$ :1. Treatment by flotation exclusively gave the highest recovery, 91 per cent of the silver and 95 per cent of the copper. The ore was crushed to pass 80-mesh and was floated with a mixture of eucalyptus oil and wood creosote in non-acid solution. The concentration ratio was  $2\frac{1}{2}$ :1.

The tentative choice seems to lie between (a) light chloridizing roasting followed by water wash and cyanidation, and (b) flotation of the entire ore crushed to pass 80-mesh. The latter process, of course, yields a product which may have to be shipped to smelters, but experiments are under way to determine the feasibility of cyaniding this product after a light chloridizing roast followed by water wash.

#### Producing Tungstic Acid at Boulder, Col.

Until quite recently the only local treatment of Boulder County tungsten ores consisted in concentration, the enriched products being shipped East for metallurgical treatment. At different times various concerns have investigated the advisability of further local treatment, producing a finished product suitable for use in metallurgy, chemistry or the textile industry, but nothing came of these investigations. Within the past month, however, the Tungsten Products Co. has been incorporated by J. H. Holmes, H. B. Holmes and Warren F. Bleecker, for the manufacture of tungsten products at Boulder, Colo. Mr. Bleecker is metallurgist in charge of technical work.

The immediate purpose of the company is the production of tungstic acid. Later on metallic tungsten may be produced. The raw material is low-grade tungsten ore mined in the Nederland district immediately west of Boulder. Low-grade ore is being used in preference to high-grade concentrate on account of the much lower cost per unit of tungstic acid contained. In brief the process consists in roasting the ore with soda ash, leaching the sodium tungstate with hot water and precipitating tungstic acid with hydrochloric acid. The ore and soda ash in proper proportions are ground in a pebble mill. The mill is lined with maple wood and the grinders are flint pebbles of local origin. The ground mixture is roasted on a reverberatory hearth, observing important precautions to secure a high percentage of soluble sodium tungstate, as well as certain physical conditions in the product which will make the subsequent leaching efficient. The roasted mixture is then transferred to vats where it is leached with water heated by live steam. The solution is filtered by vacuum, and tungstic acid is precipitated

by the addition of hydrochloric acid. This precipitate is separated from the liquor by decantation and filtration, and forms a product of immediate commercial value. While the elements of the process are comparatively simple, the success of the work depends on maintaining certain conditions in each step. The work at Boulder is starting on a small scale, with plans for enlarging as conditions demand.

#### Sulphuric Acid in Utah

An index of the development of chemical and metallurgical industry in Utah is found in the announcement by C. W. Whitley, general manager for the Utah department of the American Smelting & Refining Company, that his concern will shortly erect in the Salt Lake valley a sulphuric acid plant. It is reported that the manufacture of acid will be in conjunction with the smelting operations of the company, utilizing the sulphurous smelter gases. If the company's experiments in zinc hydrometallurgy with electrolytic deposition prove successful enough to warrant the construction of a commercial plant, much of the sulphuric acid produced will be used in the treatment of zinc ores.

#### Anaconda's Electrolytic Zinc Plant

The success of Anaconda's experiments in the production of electrolytic zinc is definitely settled by the announcement that a \$2,000,000 plant is to be constructed at Great Falls where cheap electric power is available. Research on this subject has been under way for months, and will now culminate in a plant that is to be in operation about September of this year. The reported capacity is 70,000,000 lb. per annum, and the power requirement 30,000 hp. Zinc concentrate will be roasted and leached with sulphuric acid. The solution will then be purified by precipitating iron by means of limestone and copper and cadmium by zinc. The purified zinc sulphate solution will then be electrolyzed with insoluble lead anodes and either aluminium or zinc cathodes.

#### Potash Production in Utah

The Mineral Products Company, which is exploiting the alunite deposits near Marysvale, Utah, now has its plant in operation and is producing about 25 to 30 tons of potassium sulphate per day. This pioneer work, started under the favorable conditions created by the war, is meeting with success, and the company is now contemplating the production of aluminium as well as potash. A carload of alumina by-product from potash manufacture has been shipped East for experimental tests, with the expectation of ultimately building a reduction plant in Utah. The concern is backed by men prominent in the packing and mining industries.

#### Record Production in the Joplin District

Joplin is rejoicing in a production of lead and zinc in 1915 valued at over \$26,000,000. This is a record that has no equal in former years, the nearest approach being in 1912, when the value was over \$18,000,000. Zinc concentrates constituted the largest portion of the tonnage and commanded the highest price per ton of any product of the district. In June the base price for 60 per cent zinc concentrates reached the record price of \$135 per ton. The new year opened with prices of \$85 to \$115 per ton for 60 per cent zinc and \$70 for galena, and the prospect for continued prosperity is as bright as could be asked. There appears to be no cessation in the construction of new mills and treatment plants following in the wake of high prices, and new settlements have even sprung up around plants constructed by some of the larger companies.



## The Utilization of Wood Waste

A paper read at the Baltimore meeting of the American Institute of Chemical Engineers, on Jan. 12, 1916.

BY ARTHUR D. LITTLE

Mark Twain says, "We all talk about the weather, but nothing is done." So it is with wood waste utilization. The lumbermen are interested, of course, but their interest is tempered by weariness and restrained by scepticism. They are open to conviction but would like to see anyone who can convince them. Much the same situation may be found where any of our great industrial wastes are concerned. Those who are responsible for the wastes are so close to them and so long familiar with them that they have come to regard them as the unavoidable accompaniment of the industry. Moreover plans for waste utilization commonly involve the extension of a business into regions which, however familiar they may be to those doing business in them, are new and strange to the makers of the waste. Conversely, those whose specialized experience might enable them to utilize the waste to advantage, hesitate to incur the large capital expenditure required for establishing an industry dependent upon a raw material over which they have no control and the supply of which may cease at any time, as, for example, when a lumber mill burns down.

These are real and serious obstacles in the way of the utilization of wastes, but the things which any one can do easily bring no great rewards. The world belongs to those who overcome difficulties and nowhere does it offer richer promise of potential wealth made actual than in the colossal wastes of lumbering.

The figures involved are of astronomical proportions and consequently make little more impression on the mind than the distances of the fixed stars. Let us, however, try once more to really comprehend them. On a total annual cut of 50,000,000,000 ft. broad measure, of merchantable lumber, at least 75,000,000,000 ft., or about 112,000,000 tons of wood waste is produced. For every man, woman and child in the country there is therefore annually wasted more than a ton of wood.

The proportion of waste to merchantable lumber varies within wide limits with the kind of wood. In the lumbering of hard woods, according to Goodman, only 15 per cent of the weight of the standing timber appears as finished lumber. Sixty-five to 70 per cent of the original tree is left on the ground and the mill waste amounts to over a cord per 1000 ft. of lumber. Frankforter, who had exceptional opportunities for studying the lumber industry in the middle, northern and western States reports that in these sections of the country the best equipped and most skillfully operated mills utilize a little less than 40 per cent of the total weight of wood in lumber, lath and shingles. Our own large scale studies on long-leaf yellow pine have proved that under the best operating conditions only 33.42 per cent of the average tree becomes available as lumber, box shooks, lath and shingles. Two-thirds is wasted. In the estimate given above of total annual waste an average of 60 per cent of the entire tree was reckoned as waste, but in view of the loss on yellow pine, which is our most important timber tree, and the far greater proportionate loss on hardwoods, it is evident that the total annual waste is substantially more than 75,000,000,000 ft. and may even reach 90,000,000,000 ft. Frankforter's estimate of 100,000,000,000 ft. on a smaller annual cut is undoubtedly too high and not in accordance with his other figures.

Of all our timber trees none lends itself more readily to waste utilization than long-leaf yellow pine. It is cut more largely than any other species and the individual operations are commonly on a great scale

which ensures the local concentration of waste in vast amounts. For these reasons and because my associates and I have studied the waste utilization problems presented by this wood more carefully than those of any other species I will ignore hardwood distillation, the use of extracted chestnut chips for pulp and paper making and the occasional use of mill waste from northern conifers in sulphite pulp mills, and ask you to direct your attention solely to the utilization of wood waste from long-leaf yellow pine.

The present annual cut of this species is about 15,000,000,000 ft., board measure. The waste is equivalent to 30,000,000,000 ft. It may be said at once without fear of successful contradiction that the potential profits in this waste are far greater than any actual profits which this branch of the lumber industry can be made to yield from lumber. When this waste is intelligently considered, not as waste, but as raw material, it will be seen to afford a basis for building up the greatest group of co-related by-product industries the world has ever seen. The products of these industries will comprise wood pulp, pulp boards, paper, paper bags, paper twine, turpentine, rosin, pine oil, charcoal, tar, ethyl alcohol, cattle feed, varnishes, ether, and not improbably acetic acid, wood alcohol, acetone and producer gas.

The wood of long-leaf pine is heavy, exceedingly hard, very strong, tough, coarse-grained, compact, durable and very resinous. Its density varies with the height from the ground, the age of the tree and its content of pitch or oleoresin. Sargent gives the average specific gravity as about 0.7, which would seem to be too high. Determinations in the Forest Products Laboratory ranged from 0.426 to 0.583. Determinations in our own laboratory gave 0.626 as the specific gravity of round wood averaging 7 in. in diameter. The weight per cubic foot for logging waste we found to be 39.1 lb. bone dry. The weight per cord depends greatly upon the shape and size of the pieces. On the dry basis we have found the sawdust to weigh about 1400 lb., mill waste with little or no bark 2340 lb., with much bark 1708 lb., logging waste in the form of fairly smooth round logs weighs about 3260 lb., and if rough and irregular will average 1860 lb., while mature long-leaf pine, consisting largely of heart wood, will run about 4300 lb. to the cord, bone dry.

We find the ultimate composition of long-leaf pine to be: Carbon, 53.96 per cent; hydrogen, 7.13 per cent; oxygen, 38.65 per cent; nitrogen, 0.03 per cent; sulphur, 0.04 per cent; ash, 0.16 per cent.

Our determinations of fuel value of average sawmill dust gave 9240 B.t.u., dry basis. Moisture in green wood averages 34.15 per cent, fresh green stumps average 28.69 per cent, lightwood 13.35 per cent. Stumps about six years old carry around 20 per cent of water and kiln-dried lumber contains an average of about 10 per cent.

The proportion of bark varies to some extent with the age of the tree and is relatively high. Small round Mississippi wood had about 9 per cent, Florida pulp wood over 11 per cent, and Florida trees, 18 in. diameter, bore 8.6 per cent of bark by weight.

Determinations in our laboratory of the fiber length of long-leaf pine gave a maximum of 7.40 mm., minimum 3.00 mm., with an average of 4.60 mm., as compared with 3 to 3.5 mm. for spruce.

In determining the amount of field waste under careful operation members of our organization selected five plots of one acre each as truly representative as possible of the average quality of yellow pine timber. As soon as the timber had been felled the waste between 3 in. and 9 in. was collected, classified and weighed. Much of it was also corded and scaled to determine relations

between weight, cord measure and volume. Each stump was measured and its volume and weight computed. Needles from four trees were weighed.

The main points of accumulation of mill waste are the main refuse conveyor and the main dust conveyor. Actual determinations by weight of the amounts of waste carried by these conveyors in very large scale operations were made by members of our staff. The results of these determinations in the field and at the mill enable us to state with a very close approximation to the truth the relative proportions of the initial products of the average yellow pine tree. They have perhaps never been ascertained before within such limits of accuracy or upon so large a scale. The proportions of the several products are as follows:

Tops and culls.....	22.35
Logs.....	79.56
Stumps and lightwood.....	7.09
	<hr/> 100.00

Bearing in mind that all percentages given are on the total weight of the tree, the tops and culls consist of:

	Per Cent
Needles and twigs.....	2.35
Limbs under 3 in.....	2.54
Cordwood.....	6.42
Pulpwood.....	4.54
Red and rotten.....	6.60

The logs yield:

	Per Cent
Red and rotten.....	1.45
Slabs, edgings and trimmings.....	18.07
Sawdust and shavings.....	17.62
Shingles.....	0.66
Lath.....	1.39
Lumber and box shooks.....	31.97
Stumps amount to.....	6.48
And lightwood to.....	0.61
	<hr/> 100.00

Comprehensive studies were conducted on these wastes for a period of eight months. The different classes of waste were carefully and repeatedly analyzed and their content of rosin and turpentine determined. Papers in great variety were made in our experimental paper mill under direction of Mr. V. E. Nunez, and extractions and distillations on the small commercial scale carried out in our Forest Products Department by Dr. L. F. Hawley. The results obtained, together with data from actual commercial practice, point incontrovertibly to these stupendous totals:

Upon an annual cut of 15,000,000,000 ft. of yellow pine the lumber industry in our Southern states now wastes raw material sufficient for the concurrent daily production of 40,000 tons of paper, 3000 tons of rosin, 300,000 gal. of turpentine and 600,000 gal. of ethyl alcohol, together with fuel sufficient to meet the requirements of all these industries.

Despite the prevailing opinion to the contrary among lumbermen, and even among papermakers, long-leaf yellow pine lends itself admirably to the manufacture of paper. It is too pitchy for the sulphite process, but is readily reduced to pulp by the soda process. Much the best results are, however, obtained by the sulphate process which when carried out under proper conditions yields an excellent kraft pulp and paper. The pulp bleaches with some difficulty, but may with care be brought to good color without serious impairment of strength. The bleached pulp makes good wood writings and when mixed with pulp from gumwood can be run off into good book papers. A cord and a half of round waste makes a ton of paper as against about two cords of spruce costing Northern mills from \$9 to \$13 a cord.

The production of ethyl alcohol from yellow pine waste by the Ewen & Tomlinson process has been fully demonstrated as a technical proposition, about 90,000 gal. of high-grade 95 per cent alcohol having been made

in the plant of the Standard Alcohol Company at Fullerton, La. The commercial merit of the proposition remains to be demonstrated since this company is now in the hands of the receiver for reasons altogether apart from the technical merit of the process. It may, however, be said that every technical man familiar with the process believes that it is capable of producing 95 per cent alcohol at a cost, including cooperage and all fixed and manufacturing charges, of not more than 20 cents a gallon. Such alcohol is worth to-day about 56 cents a gallon. The yield per cord of sawdust or hogged wood waste containing 50 per cent water is 10 gal. in large-scale operation, but yields much higher have been obtained in the laboratory.

The process is based, of course, on the observation of Braconnot in 1819 that cellulose by treatment with mineral acid is converted into reducing and fermentable sugars. For nearly 100 years experimenters have endeavored to develop this observation into a commercial process. With the exception of Ewen & Tomlinson all have failed to produce alcohol in commercial quantities. Simonsen in Sweden, in 1889, began a series of brilliant researches which cleared up many points of difficulty and ultimately enabled him to secure very satisfactory results on the large laboratory scale. Attempts at commercial operation, however, developed fresh obstacles, and led to the abandonment of the process. The well-known German chemist, Alexander Classen, patented during the years 1900, 1902 and 1903 various modifications of the general process of producing sugars and alcohol by treatment of comminuted wood with strong acids under heat. Subsequently several plants were built in this country for carrying out one or another of these modifications. In none of them were any substantial amounts of alcohol produced and the Classen process must be regarded as commercially inoperative. It remained for Ewen & Tomlinson to overcome the fundamental technical difficulties underlying all these attempts and to put forward the first process capable of large-scale production of ethyl alcohol from wood.

The Ewen & Tomlinson process is essentially one for producing fermentable sugars. The fermentation of these sugars, once produced, may be carried out and the alcohol recovered in any distillery by the usual methods. It is my belief that the process affords the cheapest known method for producing these sugars, and that it therefore is ultimately destined to become an important if not the most important source of industrial alcohol.

In carrying out the process hogged wood waste usually containing about 50 per cent of water is loaded into a rotary digester holding about seven cords and having a protective and heat insulating lining. Sulphuric acid in relatively small amount is sprayed upon the wood and then steam is admitted to the digester. The critical temperature is reached as quickly as possible, and the reaction is then extremely rapid, if not indeed nearly instantaneous. Pains are therefore taken to immediately reduce the pressure and to empty the digester of its contents as promptly as may be. About 25 per cent of the weight of the wood is converted to reducing sugars, not all of which are fermentable.

The cooked material, which is not unlike coarse coffee grounds in appearance, is transferred by conveyors to a diffusion battery or other extraction apparatus in which the sugars are dissolved out. The spent chips go to a continuous press for removal of excess water and are then available as fuel. The extracted juice is neutralized with lime, and is then ready for fermentation. The concentrated slop from the stills finds use as cattle feed, and is about equivalent to molasses for that purpose.

In a modification patented by me the process may be



diverted as a whole to the production of carbohydrate cattle feed. In this modification hydrochloric acid is substituted for sulphuric and subsequently removed so far as readily possible by heating or blowing air through the mass. The remaining acid is then converted to common salt by addition of an equivalent amount of sodium carbonate. The juice is extracted and concentrated to the consistency of molasses.

A major economic problem in the South which is bound up with the utilization of wood waste is that of the agricultural development of the cut-over lands. It has been demonstrated that by a steam puller yellow pine stumps may be pulled for about 33 cents each. In the trials made the stumps averaged 563 lb. each, which makes the cost of pulling \$1.16 per ton. Where logging train roads are still in place the stumps can be brought to a central plant for treatment at a total cost well within \$2.50 per cord. Treated by solvent extraction they should yield per cord about 6 gal. of turpentine, 2½ gal. of pine oil and 380 lb. of resin. The extracted chips as pointed out by Veitch and Merrill, and amply demonstrated in our experimental paper mill, are available for the manufacture of an excellent grade of kraft paper. Strangely enough and contrary to our first impression the charred portions common in such stumps are easily removed in the process and leave the paper clean. The chips are, of course, also available for alcohol production.

Stumps and the highly resinous wood residues termed lightwood, together with the box slabs from turpented trees, are directly available for treatment by several processes of distillation. The average green wood, with 35 per cent moisture, contains about 6 per cent resin, but in selected samples of wood the resin may run higher than 50 per cent. No large quantities are usually to be had, however, containing more than 30 per cent. The composition of the resin itself is variable, but in green wood it runs about 80 per cent resin, and 20 per cent volatile oils; about 80 per cent of the latter are turpentine and the balance pine oil.

Destructive distillation is carried on in retorts operated commonly without temperature control. Average yields under these conditions are:

Light oils .....	6 gallons
Turpentine .....	6 "
Heavy oil .....	16 "
Tar .....	48 "
Charcoal .....	35 bushels

Various processes in which the retort temperature is controlled, as in the bath process and the processes of Gautier, Pritchard, and others, have been proposed, and several put in operation for a time on either the commercial or large experimental scale. They offer advantages in the way of better yields and quality of turpentine, but these gains are so nearly offset by higher fuel costs and higher maintenance charges that the commercial superiority of these more complicated processes has yet to be demonstrated.

Ten years ago recovery of turpentine from comminuted waste by steam distillation was practiced in many plants, the steam being blown through the mass of chips either upward or downward, and carrying with it to the condenser the volatile oils. The decline in the price of turpentine in 1907 and 1908 proved so severe a blow to the industry that it is to-day practically wiped out.

The well-known Yaryan process added to the steam distillation method the subsequent step of extracting the chips with a volatile solvent from which the dissolved resin could later be recovered. Several plants of large capacity were operated successfully until in 1913 the failure of the American Naval Stores Co. caused a heavy drop in the price of resin, which was

followed by the failure of the company operating the Yaryan process. A contributory cause may well have been the large losses of solvent incident to the process.

Several methods have been proposed for the recovery of turpentine, pine oil and resin from yellow pine wastes by the action of water solutions of alkali, but none are thought to be operating commercially. They depend upon the fact that the wood is only slightly attacked by the dilute alkali in which the resin is readily soluble. Nevertheless, some wood is dissolved, and the difficulty of separating this so-called "humus" from the resin has prevented the introduction of processes of this type. The difficulty has been overcome in a simple and ingenious way by Whitaker and Bates, who salt out the resin soap by increasing, after the initial treatment of the wood, the concentration of the alkaline solution to 3½ per cent free alkali. The treated chips are then available as a raw material for paper making.

When the real work of wood waste utilization has once begun and the attention of chemical engineers and financial men has been drawn more generally to the huge potential values now ignorantly thrown away we may expect the rapid development of these byproduct industries and the initiation of many new ones to the great enrichment of the South and in somewhat less degree that of the Northwest. It would doubtless be too sanguine to expect the directive impulse for this new development to come from the lumbermen themselves. They are too close to the wastes. They are blinded by the sawdust. But if they fail much longer to grasp the opportunity which has been so long beside them they must be content to see others reap the benefits and profits which will come through control of processes, special apparatus, and, above all, of technique.

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## Oils and Other Reagents in Flotation

BY ROBERT J. ANDERSON

The advent and application of the flotation process, as it is now understood by its more authoritative exponents, marks one of the most noteworthy and revolutionary advances in modern metallurgical endeavor. Flotation marks a new era in the concentration of ores and of intermediary mill products. Although the process was discovered some fifty-five years ago, it is only recently that mill men and others have come to a realization of its virtues and have applied its principles on a commercial scale. This tardy application of a process so long known must necessarily be ascribed to certain inherent difficulties, which were encountered and which could only be effaced by time. Since it is not so long ago that the process was uncertain of success, the rapid strides made in the last few years can be regarded as nothing short of remarkable. Recently flotation has demanded the attention of mine operators, mill men, and others interested in the mining and metallurgical welfare of the country, particularly the United States Bureau of Mines and the bureaus of experimental research in connection with the universities teaching mining and allied subjects.

Disregarding here the mention of the manifold number of patents which have been taken out for the flotation process, the subject of litigation, and the theories which have been advanced to explain the "why" of flotation, it may be safely stated that probably nothing relative to the application of flotation on a commercial scale has received the attention which the oils have. It is a well-known fact that virtually any kind of oil, grease, or oleic acid may be used in this process; the number of oils or rather combinations of oils which have

been tried experimentally and commercially is almost without end.

This use of oils has given impetus to the production of wood creosotes and other wood fractions particularly in the South, the market for which had hitherto become rather stagnant; further, the increased production of coal tars and similar distillates in coke and gas manufacture has lately been more warranted; then, too, the petroleum industry has had a share in furnishing oils for flotation consumption.

To-day there are probably 200 flotation plants in active operation in this country, and this number is rapidly increasing as time proceeds. The flotation process will undoubtedly have a far-reaching application, but in no sense can it be looked upon as a universal panacea for all metallurgical ills. There can be little doubt that the process has come to stay, and probably its full significance is not even now realized. The metallurgical treatment of the concentrates produced in flotation presents an entirely new problem not hitherto encountered in metallurgical work and also a field for active research.

#### Oils in Flotation

There are so many oils available for use in flotation work that judicious selection has become a factor almost as important as the quality of an individual kind. In spite of the fact that considerable experimental work has been performed pertinent to the use and application of oils in flotation, there is a decided dearth of data regarding their effects and action. It is known, however, that certain oils, or rather combinations of oils, are applicable to the treatment of certain ores while others are only remotely so.

These oils, generally in mixtures of one sort or another, have been employed as flotation oils: namely, coal tar and fractions from the distillation of coal, such as coal creosotes; castor oil (mixed in small amount with kerosene or burning oil); eucalyptus oil; pine oil; pine tar; pine-tar oil; rosin and rosin oil (used for the residic acid there in); wood creosote and other products obtained in the destructive distillation of wood, such as pyroligneous acid; petroleum products of different kinds when mixed with a small proportion of the wood oils or some of the coal-tar products.

Although certain oils have all the inherent properties which would suggest their applicability as flotation oils, the fact they are prohibitively costly must act as a strong deterrent either for their use or investigation.

In the United States the oils derived from the pitch pine have given the most satisfactory results on a commercial scale; whereas in Australia, which country is in the van in flotation to-day, the essential oil of eucalyptus has been the most successful. Recent commercial practice has shown that oils of mineral origin promote the best recovery in the case of copper ores, and that oils of vegetable origin, such as the pine oils, turpentine, wood tars, and creosotes are conducive to the best recovery in the case of galena and zinciferous material.

Broadly stated, flotation oils may be classed as "frothing" oils and "collecting" oils. There is at times some difficulty in grasping the distinction between frothers and collectors as such, for one oil in itself may, and often does, possess both frothing and collecting properties. The action of a frothing oil is such as to produce froth in greater or less amount, dependent on the frothing power of the oil. A collecting oil has a collecting power for sulphides in preponderance over its frothing action, being therefor, so to speak, a poor frother; a collecting oil may have simply a collecting action and little or no frothing action. As stated in

the foregoing, some oils combine both the properties of frothing and collecting in variable degrees of each. In the flotation parlance then, the classification is given: (1) Frothing oils; (2) collecting oils.

#### FROTHING OILS

The most successful frothing oils include the pine oils, cresylic acid, and turpentine and other pyroligneous products from the distillation of wood—notably methyl alcohol. The coal tar phenols and their near derivatives, and almost or all of the so-called essential oils are good frothers. The essential oil of eucalyptus finds favor, particularly in Australian practice, on account of relatively low cost and immediate supply. Castor oil, to which reference has already been made, when mixed 1:4 with kerosene has found application. The more volatile products of petroleum, including kerosene and gasoline, have been successful frothing oils.

On some ores crude pine tar combines the properties both of frothing and collecting; on other ores it is necessary to enrich the pine tar with some such oil as turpentine, pine oil, or wood creosote. Unquestionably, pine oil (steam refined or crude) is the best frothing agent known; however, generally the selective action is not positive and marked, and the concentrates will contain gangue in considerable amount. Experiments in this laboratory indicate that cresylic acid is particularly adapted to the flotation of zinciferous material, exhibiting both good frothing and selective properties.

#### COLLECTING OILS

So-called mineral oils and tar oils do not generally form a good flotation froth, but have a marked selective action on the sulphide minerals. Among the mineral oils are included the following: asphaltum base, crude petroleum, refined oil, gasoline, burning oil, creosol and coal tar and coal-tar creosotes. Oils derived from the destructive distillation of wood, such as wood creosotes, pyroligneous acid, and the like, are found to give the best recovery on galena and zinciferous material; coal-tar products are better adapted to the successful flotation of copper bearing minerals.

It is found that thick oils tend to form viscous, coherent flotation concentrates, while thin oils form less coherent masses. The action of coal tar in stiffening a weak, ephemeral froth is indicative of the former. In general the essential oils give a coherent froth and satisfactory extraction; oils like oleic acid or candle-maker's red oil, petroleum, and lubricating and engine oils have a strong tendency to produce heavy, thick granules which will not float. Oleic acid has a well-marked power to float silica.

#### Other Reagents in Flotation

The chemicals used in connection with oil flotation include the following: sulphuric acid, bichromates, permanganates, alkaline chlorides, alkaline sulphates and bisulphates, cupric sulphate, ferric sulphate, aluminium sulphate, thiosulphates and sulphites, organic electrolytes, such as tartrates, citrates, and citric acid, and others almost ad infinitum. Generally the purpose of other reagents than oil is to aid and abet a preferential flotation between the sulphide minerals or in some cases to effect a better separation of mixed sulphides from gangue material, unless indeed they be employed to counteract the deleterious action of certain soluble constituents in either the ore treated or in the water used, or both.

Recent commercial practice indicates that the use of sulphuric acid can be dispensed with if the proper oil combination can be found. Callow\* very appropriately

\*Bull. A. I. M. E., Dec., 1915, p. 2321.



remarks that the same results can be obtained in an alkaline or neutral pulp as in an acid one. Many mills have come to the use of almost no acid or even to an alkaline electrolyte; this latter promotes good recoveries in the treatment of pyrite as well as other minerals at times.

Experiments performed here on a 60-mesh product from the Joplin district containing pyrite and galena in a calcareous gangue show the following:

1. Potassium dichromate will deaden galena and permit the flotation of the pyrite—a true preferential flotation.

2. Alkaline sulphates, i.e., sodium and potassium sulphates, promote the production of clean concentrates; the same is true of ferric sulphate  $\text{Fe}_2(\text{SO}_4)_3$ .

3. Ferrous sulphate,  $\text{FeSO}_4$ , and cupric sulphate were very harmful to the successful flotation of this particular product, flotation being practically impossible in their presence.

From these results and others of the same nature it is seen that it is of cardinal importance to ascertain the nature of the soluble constituents of the ore and also the nature of the water used in the flotation; proper precautions must be taken if anything of a deleterious character is present.

There seems to be considerable weight in the statement "a particular oil for a particular ore." In other words, no given oil can generally be employed effectively on a number of different ores. Further, different samples of the same oil will produce radically different results, as a small variation in homogeneity often engenders considerable difficulties. Usually acid will produce a concentrate free from silica, but its use can probably be just as well avoided.

**Sizing.**—Careful screen analysis with subsequent microscopic examination or wet analysis shows that in slimes, for instance, the bulk of the values obtain in the material that passes the finer meshings. And it is believed that the ordinary run of ores require grinding to 60-mesh at least for oil flotation treatment.

**Microscopic Examination.**—The microscope is an invaluable aid in flotation work of an experimental nature, effecting a large saving of time which would otherwise be consumed in tedious and long drawn-out quantitative analysis. Casual inspection under the microscope will give at once a pretty definite idea of the grade of the tailing, middling, or concentrate. Quantitative analysis is, of course, the final criterion on which to base results. The binocular microscope is more satisfactory than any other type.

**Results of Experiments on a Settled Product from the Joplin District.**—Additional experiments performed on the product mentioned above warrant these conclusions:

1. A satisfactory oil mixture would be: 5 parts wood creosote, 2 parts pine oil, 0.5 parts coal tar; or part of the pine oil may be replaced by soap solution in variable amount, thus reducing the cost.

2. A pulp dilution of 3.5:1 or 3:1 works well; the general run of data indicate that the pulp could be run as thick as possible within limits which would be occasioned by the fouling of the operation due to clogging of the test machine.

3. The action of the coal tar here is to stiffen the froth which for any reason might become weak.

4. The effect of temperature was practically nil.

5. Sulphuric acid does not increase the tenor of the concentrates.

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## Coal and Coke Efficiency in Blast Furnace Operation

BY BIRGER F. BURMAN

### Coal Efficiency

The factors that principally influence the value of a certain kind of coal for the blast furnace are ash and sulphur. Phosphorus, of course, must not be present above certain small limits, but as there are no means by which any part of the same can be eliminated, it will not here be considered. The only thing left for the coal-mine superintendent to do is to watch for the limit, stipulated by the coke maker; if the phosphorus content should be too high, the coal must be used for some other purpose.

With the ash and sulphur it is different. There is some chance of diminishing the amount of these elements in the coal, thereby making it more suitable; and as both ash and sulphur are quite deleterious in the blast furnace, any fraction of 1 per cent of either, that can be kept out, means money saved in the operation. It is, therefore, important to be on a constant guard against such materials, and as the mine is the proper place for improvements, a system of efficiency should there be inaugurated. It will then be easier for the mine superintendent to furnish a product, that ought to command a higher price than before.

It is not the scope of this article to go into the subject of coal washing, etc., or any necessary means by which the ash and sulphur constants may be lowered. No such work of improvements, however, can be made without some kind of an indicator, whereby it can be judged and the interest of the men kept up. Such an indicator is the "efficiency" percentage.

For any comparison there must be a standard. In this case local conditions will govern the nature of the same and an analysis may be adopted which is a fairly true average at the coal heretofore mined. Extremes should be excluded and only reasonable analyses for maximum and minimum amounts of ash and sulphur be adopted. For instance, coal from a certain mine gave the following analyses (dry) during a year's time:

	Ash, per Cent	Sulphur, per Cent
Maximum.....	12.00	1.35
Minimum.....	8.00	0.75
Average.....	10.00	1.05

This analysis may be adopted as a standard for next year's work and by assuming the minimum to represent 100 per cent efficiency, the "efficiency" of any other percentage composition may be figured out as in the following examples:

#### Example 1

A certain coal analyzed 10.37 per cent ash and 1.13 per cent sulphur.

To find its "efficiency" we have an increase in ash of  $10.37 - 8 = 2.37$  per cent (over the minimum of the preceding year).

$$(2.37 \times 100) \div 8 = 29.625.$$

Hence  $100 - 29.625 = 70.38$  per cent is the "efficiency" for ash.

The increase in sulphur percentage over the minimum of the preceding year is  $1.13 - 0.75 = 0.38$ .

$$(0.38 \times 100) \div 0.75 = 50.667.$$

Hence  $100 - 50.667 = 49.33$  per cent is the "efficiency" for sulphur.

#### Example 2

A certain coal analyzed 7.92 per cent ash and 0.70 per cent sulphur. To find its "efficiency" we have a de-

crease in ash below the minimum of the preceding year of 8 — 7.92 = 0.08 per cent.

$$(0.08 \times 100) \div 8 = 1.$$

Hence  $100 + 1 = 101$  per cent is the "efficiency" for ash.

The decrease in sulphur is  $0.75 - 0.70 = 0.05$ .

$$(0.05 \times 100) \div 0.75 = 6.667.$$

Hence  $100 + 6.667 = 106.67$  per cent is the "efficiency" for sulphur. With the shipment the following report is forwarded to the coke ovens:

COAL SHIPMENT NO. ....	
From mine: .....	
Number of cars: .....	
Weight in tons of 2000 lb: .....	
Date of shipment: .....	
Analysis (dry): Volatile matter .....	per cent
Fixed carbon .....	per cent
Ash .....	per cent
Total .....	
S .....	per cent
P .....	per cent
Efficiency: For ash .....	per cent
For sulphur .....	per cent

### Coke Efficiency

The value of a certain coke for blast-furnace operations is dependent on its chemical analysis, and its physical structure. As for the moisture, this may be neglected as far as it concerns the operation of the blast furnace, especially, where the gases are washed; however, it should be recorded for the sake of giving an idea of how much water is unnecessarily handled and paid for; also for the sake of determining the weight of dry coke used.

Phosphorus is, of course, of great importance, but as there is such a slight chance, if any, to diminish it, it may be safely left out in any system of coke efficiency. However, it should be noted as a record and as a check on the coal mine.

While it would be desirable to have a constant composition of the ash, there is no way by which this can be accomplished. Therefore, to record the *detailed* analysis of the ash would be of no value.

The actual value of a coke is dependent on the amount of available fixed carbon it can furnish the blast furnace, consequently the coke should be high in fixed carbon and low in ash. But in order to reach a high grade of perfection in this respect, it will be necessary to pay strict attention to moisture and volatile matter.

The object of an efficiency system, as outlined below, should be not only to improve the quality of the coke but to keep it at the same uniform analysis and physical structure. Uniformity is just as important for the blast furnace as quality because expensive disturbances are caused by a variable quality of the stock and not by a uniform stock, even though poorer.

The efficiency system being merely an indicator will give no rules or methods of working in order to keep up or improve the quality of coke produced. It will be entirely up to the coke-oven superintendent to do this. As he will be in constant communication with the coal-mine superintendent, he can demand the proper kind of raw material; after that his attention must be directed on the ovens.

The following factors are more or less subject to improvements:

- Physical structure of the coke.
- Volatile matter on the decrease.
- Fixed carbon on the increase.
- Ash on the decrease.
- Sulphur on the decrease.

Regarding the physical structure it is entirely a matter of judgment and practical experience to properly define its nature and value. Certain prearranged rules in this respect must therefore be established.

As was said under coal efficiency, there must be a

standard of comparison. Such a standard may here be the average analysis of coke (dry) for a considerable length of time, say one year, with fair maximum and minimum values defined. As an example the following analyses may be given:

	Maximum, per Cent	Minimum, per Cent	Average, per Cent
Moisture .....	3.50	1.50	2.50
Volatile matter .....	2.00	1.20	1.60
Fixed carbon .....	86.40	84.30	85.35
Ash .....	13.00	12.20	13.00
Sulphur .....	1.05	0.75	0.90

This analysis may be used for the coming year and by giving 100 per cent efficiency to:

Fixed carbon for its maximum .....	86.40 per cent
Moisture for its minimum .....	1.50 per cent
Volatile matter for its minimum .....	1.20 per cent
Ash for its minimum .....	12.20 per cent
S for its minimum .....	0.75 per cent

the efficiency of any other analysis may be determined.

### EXAMPLE

A certain coke gave the following analysis:

Moisture .....	2.59 per cent
Volatile matter .....	1.90 per cent
Fixed carbon .....	85.78 per cent
Ash .....	12.32 per cent
Sulphur .....	0.83 per cent

To find its efficiency we proceed as follows:

Moisture:	
Increase: $2.59 - 1.50 = 1.09$	
$(100 \times 1.09) \div 1.50 = 72.67$	
Efficiency: $100 - 72.67 =$	27.33 per cent
Volatile matter:	
Increase: $1.90 - 1.20 = 0.70$	
$(100 \times 0.70) \div 1.20 = 58.33$	
Efficiency: $100 - 58.33 =$	41.67 per cent
Fixed carbon:	
Efficiency: $85.78 \times 100 \div 86.40 =$	99.28 per cent
Ash:	
Increase: $12.32 - 12.20 = 0.12$	
$(100 \times 0.12) \div 12.20 = 0.99$	
Efficiency: $100 - 0.99 =$	99.01 per cent
Sulphur:	
Increase: $0.83 - 0.75 = 0.08$	
$(100 \times 0.08) \div 0.75 = 10.67$	
Efficiency: $100 - 10.67 =$	89.33 per cent

If the moisture, volatile matter, ash and sulphur should be of lower percentages than those given for the standards, the decrease in each case will, of course, add a corresponding percentage to the 100 per cent. For instance, if the ash content was 12.02 per cent, the decrease would be 0.18 and the efficiency  $100 + 100 \times 0.18 = 101.48$  per cent. The total analysis efficiency of the coke given in the example above may be considered to equal the sum of all the four efficiencies divided by 4. The total analysis efficiency is therefore

$$\frac{41.67 + 99.28 + 99.01 + 89.33}{4} = 82.32 \text{ per cent.}$$

The moisture efficiency is treated separately.

The physical structure may be given factors according to certain prearranged rules, each factor representing the efficiency given by the factor. It is not necessary to stipulate so many factors; only the factors 100-90-80-70-60-50 will do. These figures will then also stand up for 100-90-80-70-60-50 per cent efficiencies respectively.

Every coke shipment is sampled and analyzed. The following form for reporting the analysis may be used:

ANALYSIS OF .... HOURS COKE	
From coke shipment No. ...., Coal shipment No. ....	
Number of cars: .....	
Weight in tons of 2000 lb: .....	tons
Moisture .....	per cent
Volatile matter .....	per cent
Fixed carbon .....	per cent
Ash .....	per cent
S .....	per cent
P .....	per cent





Going to the slag:  $9.80 + 50.21 + 0.34 = 60.35$

Limestone required to each 100 pounds of fuel burnt =  $y$  pounds.

SiO <sub>2</sub> .....	6.02 +0.0580y	Acids.....	= 9.63 +0.0980y
Al <sub>2</sub> O <sub>3</sub> .....	0.61 +0.0400y		
CaO.....	0.966 +0.4654y		
MgO.....	0.24 +0.0278y	Bases.....	= 2.706 +0.5021y
FeO.....	1.80 +0.0089y	CaS.....	= 0.293 +0.0034y

Total..... 12.629 +0.6035y

$9.63 + 0.0980y = 2.706 + 0.5021y$

$y = 17.13$  pounds of limestone

Slag formed =  $12.629 + (17.13 \times 0.6035) = 22.97$  pounds

Sulphur present in coke..... 0.88

in limestone  $0.1713 \times 0.15 = 0.0257$  0.9057 pounds

Sulphur in slag (per cent)  $90.57 \div 22.97 = 3.943$  per cent

Total per pound of fuel burnt:

Limestone..... 0.1713 pounds

Slag..... 0.2297 pounds

Carbon to melt the slag  $0.2297 \times 0.228 = 0.0524$  pounds

Leaving for furnace available  $0.8252 - 0.0524 = 0.7728$  pounds

Carbon efficiency of coke..... 77.28 per cent

Cost (sulphur not considered):

The cost of coke  $\$2.20 \times 1 + 0.7728 = \$2.847$

The cost of stone  $\$1.10 \times (1 + 1.12) \times 0.1713 + 0.7728 = 0.218$

The cost of slag  $\$0.20 \times (1 + 1.12) \times 0.2297 + 0.7728 = 0.053$

Cost per ton of 2000 pounds of pure available carbon..... 3.118

Cost per ton of 2000 pounds of coke  $3.118 \div (1 + 0.7728) = 2.410$

#### COST (SULPHUR CONSIDERED)

Only a limited amount of sulphur can be kept in solution by the blast furnace slag without danger of being absorbed by the pig iron. Often the amount of slag is quite sufficient to take care of the sulphur, brought in by the fuel, but more often extra slag has to be provided for. This is quite an item, as will be seen from the following.

A new standard has to be adopted, namely, the amount of sulphur the slag shall be allowed to carry. This will here be assumed to be 1.40 per cent for our special example.

22.97 pounds of slag satisfy  $0.2297 \times 1.40 = 0.3216$  S

Sulphur present (see above)..... 0.9057 S

Net sulphur for which outside slag must be provided..... 0.5841 S

(See Coke and Limestone, Supplement, Case V.)

Requirements: Slag produced 79.96  $\times 0.5841 = 46.70$  pounds

Fixed carbon consumed 18.23  $\times 0.5841 = 10.65$  pounds

Stone consumed 79.36  $\times 0.5841 = 46.35$  pounds

Sand or its equivalent 32.07  $\times 0.5841 = 18.73$  pounds

Total per pound of fuel burnt:

Fixed carbon..... 0.7728 - 0.1065 = 0.6663 pounds

Limestone..... 0.1713 + 0.4635 = 0.6348 pounds

Sand or its equivalent..... 0.1873 pounds

Slag..... 0.2297 + 0.4670 = 0.6967 pounds

Carbon efficiency of coke..... 66.63 per cent

Sulphur in coke..... 0.88

Sulphur in stone  $0.6348 \times 0.15 = 0.0952$  0.9732 S

Sulphur in slag (per cent)  $97.32 \div 69.67 = 1.40$  per cent

The cost of coke  $\$2.20 \times 1 + 0.6663 = \$3.302$

The cost of stone  $1.10 \times (1 + 1.12) \times 0.6348 + 0.6663 = 0.936$

The cost of sand or its equivalent  $1.10 \times (1 + 1.12) \times 0.1873 + 0.6663 = 0.276$

The cost of slag  $0.20 \times (1 + 1.12) \times 0.6967 + 0.6663 = 0.187$

Cost per ton of 2000 pounds of pure available carbon..... \$4.701

Cost per ton of 2000 pounds of coke,  $4.701 \div (1 + 0.6663) = 3.132$

Cost due to sulphur alone (no cost for reduction included): per ton of 2000 pounds

of coke  $3.132 - 2.410 = 0.722$

The report on coke consumed as shown at the bottom of page 139 is filled out every day and at the end of the week completed on the average analysis.

#### AVERAGE ANALYSIS FOR THE WEEK:

	Dry	Wet	
Moisture.....	.....	.....	SiO <sub>2</sub> .....
Volatile matter.....	.....	.....	Al <sub>2</sub> O <sub>3</sub> .....
Fixed carbon.....	.....	.....	CaO.....
Ash.....	.....	.....	MgO.....
P (remaining in the ash).....	.....	.....	FeO.....
S (remaining in the ash).....	.....	.....	P <sub>2</sub> O <sub>5</sub> .....
S (remaining in the combustibles).....	.....	.....	CaS.....
Total.....	.....	.....	.....
Slag produced per unit of coke burnt.....	.....	.....	.....
Sulphur in slag.....	.....	.....	.....
Carbon efficiency.....	.....	.....	.....
Cost per ton of pure available carbon.....	.....	.....	.....
Cost per ton of coke.....	.....	.....	.....
Cost per ton of coke due to sulphur alone.....	.....	.....	.....

(To be concluded)

**Improvements to Smelter.**—Improvements to cost \$100,000 will be made to the Tacoma smelter of the American Smelting & Refining Co.

## An Electrically Heated Bomb Furnace

BY D. F. CALHANE AND H. A. LAVENE

Certain classes of chemical reactions are carried on under pressure in sealed glass tubes. The most common of these reactions are those for the determination of chlorine, bromine, and iodine in organic substances by heating them under pressure with nitric acid.

The type of furnace most generally used consists of from eight to ten iron pipes that are fastened in a frame, enclosed by an air bath that is heated by gas ring burners. Channels around the pipes for air circulation provide for even heating. To protect against injury from the explosions of the tubes that frequently occur, there is a swinging triangular door at the ends. The rate of heating is determined by the size of the gas flame.

This furnace has several disadvantages, such as the following: With gas heating it is more or less difficult to bring the furnace up slowly and evenly to full heat and then maintain a constant temperature for a considerable interval of time. Varying gas pressure and air drafts seriously interfere with even heating. The explosion door does not work to full satisfaction. It allows of drafts; and particles of glass from the explosion of tubes in the top pipes, are reflected back into the lower tubes, causing these to explode. Glass particles from exploding tubes in lower pipes are sent out into the room from the fact that the door swings too far out from the impact with the longer lever arm. The gas flames are invariably put out by an explosion, causing delay.

For these reasons, the electrically heated furnace described in this article was designed and constructed. This does away with all gas troubles, and the new type of door devised eliminates dangers from flying glass particles.

In the construction of the furnace, eight small iron pipes are arranged around the central larger pipe, in a circle. These eight pipes are of  $\frac{3}{4}$ -in. standard wrought-iron tubing, and the central pipe is  $1\frac{1}{4}$ -in. tubing. The pipes are 25 in. long. A pin is inserted near the end of the pipes and a corresponding slot is cut in the retaining frame, thus permitting the removal of the tubes from the furnace for unsealing the contained glass tube.

The heating element is nichrome wire of the ribbon type. This is wound on insulated iron pipes that form the outer and inner winding frames. The outer pipe is a 25-in. section of 6-in. steam pipe, and the inner pipe is a 23-in. length of the standard  $1\frac{1}{2}$ -in. wrought-iron tubing. For insulating the heating wire from the iron pipes, a  $\frac{1}{4}$ -in. layer of alundum cement is used. The mass of iron gives good inertia to sudden possible heating variation, and thus makes for even temperature rise. The windings on the outer and inner frames are in series, giving the simplest electrical arrangement. The inner winding frame is easily removable through a detachable plate in the retaining frame. The wire on the inner frame is wound over the alundum-cement covering and then covered with a thin outer layer of the same cement. Over all is a jacket of thin sheet iron to protect the winding from mechanical injury.

In the case of the outer winding, the wire is wound with  $\frac{1}{2}$ -in. space between the convolutions and covered with a thin layer of cement to protect from oxidation. A removable heat insulating muffle of alundum cement composition comes next, and around this a jacket of magnesia pipe insulation, such as is commonly used for steam-pipe covering. The air film between the two jackets will be a more efficient heat insulator than a solid joint. The desirable thickness of these insulating jackets was given from those used in another furnace



of same type, designed and operated here for various heating purposes. The general appearance of the heating elements is shown in Fig. 1.

In devising an explosion door an attempt was made to avoid the troubles that arise with the use of the hinged, triangular type of ballistic door.

When a reaction tube explodes in the furnace, the gas pressure sends the glass fragments out and smashes them against the end door. So the door has to relieve the gas pressure and withstand the blow of the glass fragments. The usual type of door is hung on the furnace at an angle of 30 deg., with the idea that the force of the explosion will carry the door out to 45 deg., where the law of incidence and reflection angles will cause the glass fragments to be entirely deflected down to the supporting bench on which the furnace stands. The failure of the door to act properly is due to two reasons. One is that the force of the blow varies, and secondly that the lever arm is shorter in case of an explosion from the upper tubes than it is where an explosion from the lower tubes occurs. These surmises were tested experimentally as follows: A rifle loaded with scatter shot was fired through the different tubes against the swinging door. Beforehand the other seven tubes, the wall behind the door, and the top of the table beneath, were covered with sheets of paper. The different paths of the shot could thus be registered on the paper. There were eight tubes in the furnace, two in a row, and four rows high.

In the case of the two middle tubes, the door worked fairly well. No particles of shot were deflected back into the other pipes and none were projected out into the room. In the case of the two lower tubes, nearly all the shot went out into the room. When fired from the top tubes it was found that nearly all the shot was deflected into the next tubes lower down. The effect of this in exploding other tubes heating in the lower rows is easily imagined. These experiments showed very conclusively that the swinging, ballistic type of door is unsatisfactory. After some study, a pop valve type of door was designed. This would consist of an iron cap,  $\frac{1}{4}$  in. thick, and 11 in. in diameter, with a  $\frac{1}{8}$ -in. flange  $1\frac{3}{4}$  in. deep on the rim. This cap fits over each end of the furnace and supports the door mechanism. The door frame consists of an iron, flat ring,  $\frac{3}{16}$  in. thick and  $8\frac{3}{4}$  in. in diameter that is hinged to the cap. Secured to this door ring are two cross strips of  $\frac{1}{4}$ -in. x  $\frac{5}{8}$ -in. stock, whose ends are bent down to form feet that are screwed to the ring. In this way,  $\frac{3}{4}$ -in. clear-

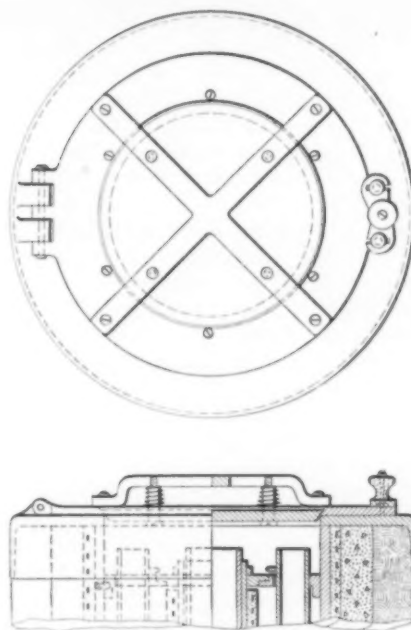


FIG. 2—DRAWING OF DOOR AND FURNACE END

ance between the under side of the cross strips and the door proper is attained.

The door itself is an iron disk 6 in. in diameter and  $\frac{5}{16}$  in. thick. Four screws secured to the cross strips pass four holes in this disk with a  $\frac{1}{16}$ -in. clearance. Four conical springs on the shank of these screws, exert tension on the disk, which has a 30-60-deg. bevel around it, forming a shoulder that allows the disk to find its own set against the inner edge of the flat ring, and thus make a tight closure under the spring tension. At whatever point the disk is struck, it will give and release the pressure against the spring tension, returning instantly to its fixed position. The whole mechanism is fastened to the end caps by a catch arrangement.

The furnace is supported on feet, at a height of 6 in. from the table, and rests in two semicircular iron hoops secured to the supporting frame work. The furnace is tilted by making two of the feet  $\frac{3}{4}$  in. shorter than the others.

A face and sectional drawing of the door and furnace ends is given in Fig. 2; also a view of the completed furnace in Fig. 3.

The next problem was to calculate the input sufficient to reach a maximum desired temperature at a desired rate. The upper temperature limit was set at 350 deg. C. that is to be attained in four and one-half hours. The rate of heating for the kind of work the furnace is to do must be even and fairly slow, and under good control.

Until very recently there was no path open to a satis-

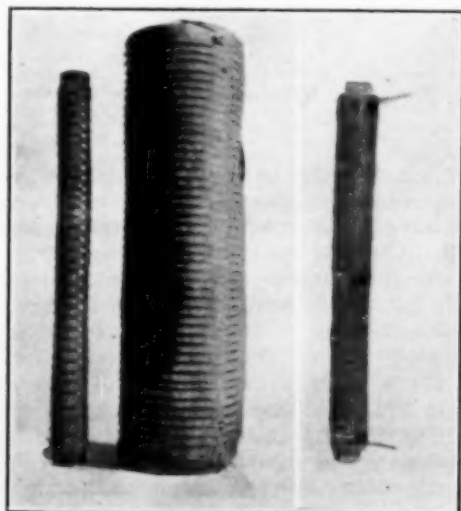


FIG. 1—HEATING ELEMENTS

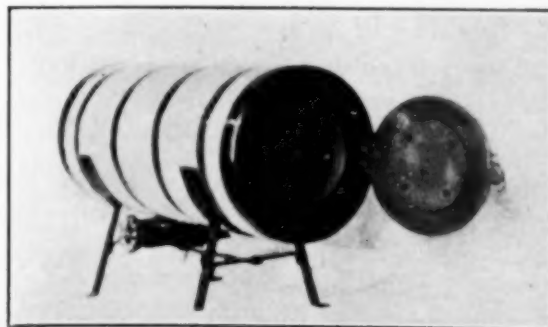


FIG. 3—COMPLETE FURNACE

factory solution of such a problem, and cut and try was the only course. After a study of the papers by C. Hering<sup>1</sup> and I. Langmuir<sup>2</sup> a set of principles was selected from them that appeared to lead to a satisfactory approximation of the results desired. These principles deduced in these papers, although concerned with the design of large furnaces, might be also applied to small ones.

1. In a rather approximate calculation of this sort the heat losses by conduction only will be considered. In a furnace of this type, radiation and convection losses will be very small.

2. The wattage input is always balanced at equilibrium by the heat loss through the walls.

3. The flow of heat through a furnace wall is almost exactly analogous to the flow of electricity. The different components of the wall offer resistance to the flow of heat just as certain media do to the flow of the electric current. The total resistance of different layers is the sum of their separate resistances if in series. So the electrical formula  $R = r + r' + r''$  applies, in which  $R$  is total resistance and  $r, r', r''$  the separate resistances.

The volt or pressure factor is comparable to the temperature. The ohm is similar to the thermal resistance unit or "thermal ohm." The ampere is likened to the amount of heat flowing. The analogy breaks in that the temperature coefficient of the thermal ohm has a negative sign.

4. The thermal ohm is that unit of resistance requiring a drop of 1 deg. C. for 1 watt of heat flow.

5. From the above the ordinary resistance formula may be applied:

$$R \text{ (resistance)} = \frac{L \text{ (depth of wall)} \times r \text{ (spec. resistivity)}}{S \text{ (average cross-section)}}$$

6. Carrying out the analogy of heat and electricity still further, Ohm's law may be applied to represent the flow of heat.

$$W \text{ (heat flow in watts)} = \frac{T \text{ (temp. drop between inner and outer surfaces)}}{R \text{ (thermal resistance in thermal ohms)}}$$

7. From (5) and (6) we get by substitution  
 $W = (TS)/(lr)$

8. According to Nusselt, the thermal resistance is halved for every 273 deg. rise in temperature. Therefore the higher the temperature, the lower the resistance, and the greater the heat loss.

9. A joint or a crack makes a very good heat insulator. Still air is a poor heat conductor. A porous substance is a good heat insulator as it contains a large amount of still air. The effect of contact resistance is met with when heat flows from one medium to another.

10. Waste space in a furnace should be avoided. The smaller the insulating air space the better.

11. The average cross-section of a wall will be figured as the arithmetical average of the surface of the inner and outer walls, or

$$\frac{1}{2} [S \text{ (area outer surface)} + S \text{ (area inner surface)}]$$

The dimensions of the furnace are as follows:

Length of outside winding frame.....	= 25 in.
Inside diameter of outside winding frame.....	= 6.125 in.
Outside diameter of outside winding frame.....	= 6.625 in.
Outside diameter of alundum insulation.....	= 7.125 in.
Outside diameter of muffle insulation.....	= 8.875 in.
Outside diameter of magnesia covering.....	= 11.000 in.
Length of inner winding frame.....	= 23 in.
Diameter of inner winding frame.....	= 2.25 in.

From the foregoing principles and dimensions the thermal drop through the walls was determined.

<sup>1</sup>Carl Hering. Heat Insulation of Furnace Walls. 1910-1912 Met. & Chem. Engineering.

<sup>2</sup>Langmuir, Meikle & Adams. Flow of Heat Through Furnace Walls. 1913. Trans. Am. Elec. So. Vol. 24, p. 53.

The constants for the thermal resistances of the materials in the furnace insulation were corrected to represent the average resistance between 25-350 deg. C. Most of the constants were given in Hering's tables, *op. cit.*, between limits 20 deg.-188 deg. C. We have as the corrected resistivities between 25 deg.-350 deg. C.

Iron .....	0.8
Magnesia covering.....	500.0
Asbestos cement .....	130.0
Still air .....	100.0
Alundum cement .....	15.0

A typical calculation of the heat loss from the outer winding through the insulating walls will suffice to show the general method of approximating this value. The heat flow is from wires to asbestos muffle, to magnesia covering out to outside air. Asbestos muffle:

Average surface =  $\frac{1}{2}(S + s)$ , in which  $S$  and  $s$  are the areas of outer and inner surfaces respectively.

$$1. \text{ We have then average area} = \frac{\pi DL + \pi dl}{2} = \frac{3.1416 \times 7.125 \times 25 + 3.1416 \times 8.875 \times 25}{2} = 630 \text{ sq. in.}$$

$$2. R = \frac{\text{depth} \times \text{sp. resist.}}{\text{av. cross-section}} = \text{resistance of wall to flow of heat.}$$

$$\approx \frac{0.875(\text{depth}) \times 120 \text{ sp. resist.}}{630 \text{ av. cross-section}} = 0.167 \text{ thermal ohm.}$$

Solving again by (1) for magnesia covering we have 781 sq. in. for average cross-section. Applying this value in (2) equation we obtain 0.678 of a thermal ohm.

The total resistance to heat flow of outer covering will be  $R$  for asbestos plus  $R$  for magnesia, or  $0.678 + 0.167 = 0.845$  thermal ohm, the total resistance. Applying from principle (6) the formula:

$$W = \frac{T}{R}, \text{ or loss in watts, } W \text{ equals total temperature drop, } T \text{ divided by thermal resistance}$$

$$\frac{350^\circ \text{ (inside temperature)} - 50^\circ \text{ (outside temperature)}}{0.845 \text{ (total resistance of insulation)}} = \frac{300}{0.845} = 355 \text{ watts.}$$

Similarly, the loss from inner winding was calculated to be 205 watts. The total thermal resistance from inner winding out was, air space, 0.642; thin alundum and sheet iron on inner winding tube plus iron of outer 6-in. pipe, plus  $\frac{1}{4}$ -in. alundum on outer pipe, 0.005 thermal ohm. As above, outer coverings, 0.845 thermal ohms. Total, 1.492 thermal ohms. 300 over 1.492 = 205 watts.

Loss from both ends through media of iron frame or pipe, plus air space, plus iron door, was 150 watts.

Total loss of heat from furnace was then

Heat loss from outer element.....	355 watts
Heat loss from inner element.....	205 watts
Heat loss from ends.....	150 watts

710 watts at 350 deg.

Next, it is desirable to know the number of watts that expended in the furnace will raise its temperature 1 deg. C. This gives the heat equivalent of the furnace. There are 80 lb. of iron in the construction and 10 lb. of alundum. The specific heat of iron from 25 deg.-350 deg. is 0.135; the specific heat of alundum is likewise 0.198. The iron equivalent is  $80 \times 454$  (mass in grams)  $\times 0.135 = 4903$  calories. The heat equivalent for alundum is  $10 \times 454 \times 0.198 = 899$  calories. This gives a total of  $4903 + 899$ , or 5802 calories.

The time it will take the furnace to rise to a given temperature will be determined by the energy supplied per second, energy lost per second, and the heat equivalent of the furnace.

The heat equivalent has been figured above, and the energy lost per second at certain temperatures has been



calculated. The supply of energy is to be determined. At 350 deg. temperature for the inside of the furnace the loss has been calculated to be 710 watts through the walls. Then the approximate time to rise to 350 deg. C. would be figured as follows:

$$\text{Time in hours} = \frac{350 \times 5802 \times 4.2 \text{ (cal. to watts)}}{3600'' \times (\text{input} - \text{aver. loss}) \text{ per sec.}} \\ = 4.3 \text{ hours.}$$

If we figure on an input of 900 watts and a loss of 710 watts at 350 deg., the average loss from room temperature up to 350 deg. will be 355 watts. This gives 4.3 hours, as approximate time of heating with 900 watts. From this it will be seen that 900 watts is a desirable input, that allowing for temperature coefficients in windings will raise the furnace to 350 deg. in about four and one-half hours. This was found to be the case in actual test as shown later.

In winding the furnace, allowing  $\frac{1}{2}$  in. between convolutions, and with 24 in. winding surface on outer element, the calculation gave 98 ft. for outer and 20 ft. for inner tube. The ratio of masses of outer to inner is as 5 to 1. Total length of wire 118 ft. It was calculated that 120 ft. of  $\frac{1}{8}$ -in. ribbon should allow— $\frac{900}{110}$  amp. to flow without undue heating of the wire. Accordingly, No. 18 nichrome ribbon wire was chosen from the Driver-Harris specifications. This gave a ribbon nearly  $\frac{3}{64}$  in. thick and  $\frac{1}{8}$  in. wide.

In winding this wire on the inner tube, which is  $2\frac{1}{4}$  in. in diameter gross—that is, including the alundum insulation—it was first wound in a lathe on a  $1\frac{1}{2}$ -in. arbor under sufficient tension to hold the turns in place. The lathe gears were set for a 2-in. thread that gave two turns per inch with  $\frac{1}{2}$  in. between turns. On releasing the tension a spring was obtained of exactly  $2\frac{1}{4}$  in. diameter. This was slipped over the inner heating element, and twisted until the turns laid tight. A coating of alundum cement was applied, and over this was wrapped a double layer of thin asbestos paper. The whole element was now covered with a sheath of thin iron to protect the winding from possible injury in withdrawing the heating tubes.

In winding the wire on the outer cylinder, this had to be done by putting the pipe into the lathe and winding on the wire, securing the ends by clamps. Care must be taken not to use too much tension as the alundum insulation is apt to be cracked off.

In the testing of the completed furnace, a series of four constantin-thermo couples were used, each one being placed in a pipe differently situated in the furnace. These couples could be rapidly read by a master switching arrangement, with a mirror galvanometer,

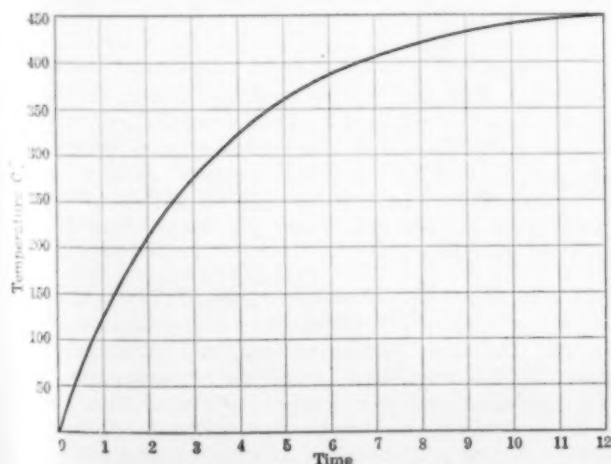


FIG. 4—HEATING CURVE OF FURNACE

whose scale was calibrated against the vapor temperatures of different chemical substances.

With an average of 106 volts and 8.2 amp. the furnace reached 350 deg. in four and one-half hours. With an average of 8 amp. and 108 volts the final equilibrium temperature was 450 deg., attained in eleven and one-half hours.

Fig. 4 below gives a heating curve that is averaged from four different heats. This is accurate within 10 per cent.

The explosion doors were tested by heating tubes thinly sealed and carrying as much as 6 c.c. of nitric acid until they exploded. The doors worked very well. Only a fine dust of glass came into the room that was carried out by the acid fumes. To avoid all possible chance of this, sheet iron hoods are slipped over the ends of the furnace. These are 5 in. deep and have a hole in the center  $3\frac{1}{2}$  in. in diameter, covered with wire gauze for release of air pressure during explosion. These hoods prevent any glass whatsoever coming into the room, and also muffle the sound of the explosion to a dull rumble, whereas it is ordinarily like a heavy rifle report.

This furnace, with hoods as just described, can be attached to any suitable commercial 110-volt circuit on any bench in the laboratory without causing any trouble to near-by workers.

For regulating the temperature through certain desired intervals, a rheostat was devised with a dial switch, as shown in the cut of the completed furnace. This provides for ten steps in the temperature scale, from 200 to 450 deg. in intervals of 25 deg.

From calculations previously given, it is found that at 200 deg. the wattage supplied to the furnace is 260. At this point the maximum resistance needed is in series with the furnace.

The calculation of this resistance may be performed as follows:

Let  $E$  be the supply voltage — 110; also let  $I$  denote the value of the current flowing. Wattage desired 260. The resistance of the furnace is  $R = 13$  ohms. Desired resistance in the rheostat  $R'$ . Then  $E = I(R + R')$ , or  $110 = I(13 + R')$ . Also power or wattage  $= EI = 260 = RI$ . Whence  $260 = I \times 13$  and  $I = 4.15$  amp. Substituting in equation above —  $110 = 4.15 \times (13 + R')$ ; whence  $R' = 13.5$  ohms.

So a length of wire having a total resistance of 13.5 ohms is desired.

Now at 350 deg. heat in the furnace, the wattage input is  $710 = EI = RI$ , whence  $710 = I \times 13$ , and  $I = 7.4$  amp. Substituting, we have  $E = I \times (R + R')$ ; when  $R' = 1.37$  ohms in resistance box. Then the potential fall through resistance box equals from the proportionality law —  $E : E' :: (13 + 1.37) : 1.37$ ; when  $E'$ , the drop in resistance box, equals 11.6 volts. The wattage consumed is  $11.6 \times 7.4 = 86$  watts. Similarly for lower limit of 200 deg. The current flowing is 4.15 amp. and resistance in box is 13.5 ohms. The potential drop figures 56 volts, and the wattage is  $4.15 \times 56 = 232$  watts. This gives maximum heating wire must stand. On the basis of these figures, No. 17 nichrome wire was selected, having 264 ohms per 1000 ft. The box is constructed of sheet iron built on slate slabs; it measures  $1\frac{1}{2}$  in. x 4 in. x 7 in. The wire was crimped into a spring  $\frac{3}{8}$  in. diameter, giving thirteen turns to the inch, and in each inch of spring there are  $1\frac{1}{2}$  ft. of wire. There are ten separate coils, in two rows of five coils each, one row above the other. The various terminals are brought out to brass plugs in a fiber disk and contacts made successively with the various coils by the dial switch.

Electro-Chemical Laboratory,  
Worcester Polytechnic Institute.

## The Development in the United States of the Manufacture of Products Derived from Coal

A paper read at the Baltimore meeting of the American Institute of Chemical Engineers, on January 12, 1916.

BY H. W. JORDAN

During 1915 we read statements in the press almost daily which gave the impression that our American chemical industry was wholly unable to manufacture synthetic coal products, and that the only relief in sight was from the wonderful discoveries of a small group of chemical amateurs, who, having patriotically hurled themselves into the situation since the war began, were on the verge of evolving the entire 900 synthetic coal tar dyes and the whole list of pharmaceuticals from palmetto and other sources, hitherto unsuspected as being fundamental to organic chemical products. These statements, by implication, and by omitting mention of the extensive plants erected and put into operation by the old, established chemical companies in 1915, tended to create the public belief that these companies were doing nothing to supply the American market.

Some of the most important products which were widely heralded as having been produced for the first time in America in 1915, were manufactured by these companies 15 to 30 years ago. Benzol and its homologues have been regular American products, with shipment in carload lots or tank cars, and with occasional exportation to Europe, since 1900. Salicylic acid was manufactured at Jersey City by Zinsser & Company from 1880 until 1897, when foreign competition closed the plant.

### SYNTHETIC CARBOLIC ACID

Synthetic carboic acid was manufactured by the Semet-Solvay Company from benzol at Syracuse in 1900 and the following years, in quantities up to 2500 lbs. daily. This carboic acid was synthesized into trinitrophenol, commonly known as picric acid, which was bought by the United States Government for use in national defense. The United States had several well equipped plants, prior to 1885, for manufacturing the principal coal dyes of that day. The industry grew, and produced an increasing number of synthetics, from which all those survive which could surmount the natural and artificial barriers in the road to a complete American coal products industry. The principal ones of these manufacturers have continued without interruption, and constitute the main body of our present organic chemical industry.

The failure to give credit in the daily press for the large amount of capital invested, and for the extensive work accomplished during the past year, is not fair to these American companies which built up our great American chemical industry during the past 30 years, and who are now the prime movers in expanding our American coal products industry to meet the new conditions.

The Benzol Products Company is an example of this growth. Organized in 1910 by men long associated with the acid, alkali and coal products industry, it began the manufacture of aniline and aniline salt at Frankford, Pa., in the aniline plant operated several years before by the late Dr. Jayne. Although the company's output of aniline in 1910 was but a small percentage of the American consumption, the English and German producers immediately dropped the price from 10c or 11c per lb., where they had held it for several years, to 9c or 8c per lb.

Most of the American consumers of aniline refused

to buy this American aniline at the fair price of 9c to 10c at which it was offered. Instead they followed their usual custom and sacrificed the American producer by supporting the cut-rate foreign producers.

These American consumers were the very ones who rushed to Washington when the war began, and frantically implored the Department of the Interior to dig up right away, quick, through the Division of Mines, some unfailing source of supply to provide the two thousand or more synthetic coal dyes and pharmaceuticals which had required 45 years of German science and organization to develop. The trip to Washington was easy for them. They had been there repeatedly since 1880, whenever a tariff bill was under consideration, to advocate no tariff on dyes.

The Benzol Products Company received the support of a few of the most far-sighted American consumers, who realized that the permanent establishment of aniline manufacture in the United States was of far greater value than the profit for a few years on their purchase of aniline, at 2c per lb. below its former price. With their support the manufacture of American aniline was continued.

Since the war, a new plant was built at Marcus Hook, Pa., and put into operation in August, 1915, with ultimate capacity equal to the former United States consumption of aniline. Notwithstanding war conditions, which multiplied the price of its raw materials, benzol, sulphuric acid and nitric acid, the company sold its aniline at a price less than half the prevailing market price of aniline, during 1915.

This production of aniline, supplemented by that of a few other plants, has supplied the American market to a fairly comfortable extent.

The Benzol Products Company's aniline has been distributed, by preference, to those consumers who employ directly or indirectly the greatest number of people. The important fact is that in 1916 a supply of aniline equal to the former American consumption will be available at fair prices, and that this supply is not coming from mysterious nor untried sources.

### BENZOL SUPPLY

Since 1900 the production of benzol has steadily increased in the United States, so that there was enough benzol at all times for the manufacture of dyes, if the industry had been established by the assistance of the federal government and by the sustained support of the American textile manufacturers. Not only were both these lacking, but the textile manufacturers persistently favored the English and German producers in preference to any American manufacturers.

Benzol supply is only one factor, and alone it is not sufficient to justify the very heavy investments required to establish an American coal products industry.

In 1915 several steel companies operating by-product coke ovens, installed benzol recovery plants, so that a heavy production of American benzol is assured. When the war ends the output from these plants will be so abundant that it may become available as motor fuel for automobiles. In this service, 1 gallon of motor benzol gives 15 per cent greater mileage than does 1 gallon of gasoline.

### ACIDS AND ALKALIES THE FOUNDATION OF COAL PRODUCTS INDUSTRY

Under the abnormal conditions and inflated prices caused by the war, many small plants sprung up and have produced products derived from coal at a profit. At the end of the war these plants will fall like autumn leaves. A few will struggle on and consume their war profits in hopeless endeavor to establish permanent busi-



ness. Only those built on a firm economic basis will survive.

The manufacture of products derived from coal is not an industry by itself. It is founded upon, and is an extension of, the manufacture of mineral acids and alkalis, and was created as a means of making a wider market for those acids—sulphuric, nitric, hydrochloric, acetic, for chlorine and the like and a market for the alkali products, soda ash and caustic soda. For this reason a permanent coal products chemical industry cannot be created in America except by co-operation with, or extension of, the American acid and alkali manufacturing companies.

#### THE VALUE OF EXPERIENCE

In 1915, with prices ten to fifteen times normal, it was possible to manufacture some coal products with large profit in the United States. With the return to normal conditions, we must conduct our processes with keenest attention to the most scientific methods, because losses of 1 per cent or 2 per cent in the steps of manufacture mean bankruptcy.

Proof that Americans sadly lack this scientific detail was given in 1915 by the many serious accidents, fires and explosions in plants manufacturing these products, the cause of which was faulty engineering design, inexperienced superintendence, untidy plant housekeeping and careless workmen.

With unconscious humor, we have done homage to German efficiency by ascribing these accidents to the German diplomatic service.

To illustrate the necessity of attention to detail, take synthetic manufacture of carbolic acid. This process, starting from pure benzol, involves five chemical reactions and from ten to fifteen chemical operations, if all by-products be recovered. If an avoidable loss so small as 1 per cent or 2 per cent be permitted in each of these steps, the final yield of carbolic acid would be so low that the process might be a commercial failure. Yet carbolic acid is one of the most simple products to manufacture.

Many others involve more steps, or steps in which the lack of technical skill produces larger loss. For example, a certain product with a normal price of 30 cents per pound has a possible maximum yield of 100 units attainable by extreme care in manufacture. With moderate care the yield drops to 88 per cent, and with ordinary care the yield drops to 75 per cent. Expressed in dollars and cents the result per ton is:

Possible yield, 100 per cent, 2000 lb., at 30c.....	\$600.00 per ton
Usual yield, 88 per cent, 1760 lb., at 30c.....	528.00 per ton
Common yield, 75 per cent, 1500 lb., at 30c.....	450.00 per ton
Loss, at 88 per cent.....	72.00 per ton
Loss, at 75 per cent.....	150.00 per ton

#### NATIONALIZATION OF THE INDUSTRY

Approach to 100 per cent technical efficiency is not the only requisite for commercial success. The intricate processes yield numerous by-products. Some are acids and alkalis which must be recovered and returned for use in the process. Others are salts or coal products which must be refined and sold. For many of these no market exists in the United States.

A network of markets must be created for every one of these by-products, either in the United States, in South America, Asia or Europe, if our American coal products industry is to grow with the world and pay reasonable dividends on the investment.

It is not sufficient that American consumers acquire the habit of buying chemicals "made in the United States." Our chemical industry, to endure, must cover the world's market; indeed, its ultimate success may depend upon an American merchant marine.

The German system of nationalized industry handles this multitude of by-products with military precision, by fitting each one into the particular technical and commercial chink best suited to it, so that all by-products are marketed at or about cost. This permits the main product to be sold at a profit large enough to sustain the normal growth of the plant and to develop new products, without adding new capital, and in addition to pay 10 per cent to 25 per cent dividends.

In complete contrast it has been, and is, the policy of our federal government to forbid any such interlocking national co-operation.

#### NATIONAL DEFENSE

The coal-products chemical industry is vital to national defense. One source of the extraordinary military strength of Germany is her ability to manufacture ammunition, literally from the air and earth, in unlimited quantity. This ability was created by the chemical industry, which built huge works and trained an industrial army of men with the scientific knowledge and technical skill necessary to transform the nitrogen of the air, and certain ones of the coal products, into ammunition. The fundamental reason for the support which the Imperial Government gave to the coal-products industry was that Germany should develop a supply of ammunition adequate for national defense and world conquest.

While developing home resources, the German industry bought benzol, carbolic acid and other crude coal products from England, thus absorbing England's commercial and military strength. Meanwhile we were more backward than England, for we were so quick to grasp the red-hot opportunity presented by German dyes and pharmaceuticals at low prices that we did not even take the trouble to produce enough crude coal products to export.

Ammunition cannot be manufactured in sufficient quantity during the interchange of diplomatic notes prior to war; it must be manufactured and stored long in advance of hostilities. One main national defense is that great coal-products chemical plants be established and operated steadily at commercial profit during peace, so that they will be instantly available to produce unlimited ammunition during war.

In 1915 we built many ammunition plants in the United States, every one on an artificial basis; few of them can make a profit at peace prices. Unless the United States establishes a complete and profitable national coal-products industry on a basis to keep abreast with all scientific progress, our program of "National Preparedness" will descend to the plane of comic opera.

#### NITRIC ACID FROM THE AIR

Nitric acid from the air is one step in such scientific progress. Our supply of nitric acid comes now from nitrate of soda imported from Chili. After the war, if the importations are not obstructed, we will receive nitrates and nitrogenous products manufactured in Norway and Germany by fixation of atmospheric nitrogen. Part of these products will be for fertilizer, part for explosives.

Exhaustion of the nitrate of soda mines in Chili will ultimately make the United States wholly dependent upon this European supply, unless we manufacture our own nitrates and nitric acid from the air.

The potash situation is a parallel condition. With German potash cut off, we have no potash. Various American sources will be brought into operation, but several years must elapse before we produce all the potash we consume.

Fixation of atmospheric nitrogen as nitric acid will also require several years, even though the Federal Government give the manufacture its strongest support.

Nitric acid is the effective end of every explosive and is the first chemical reagent used in the manufacture of aniline, and thence of indigo and others of the most important coal products and dyes. Without nitric acid, our entire navy, army and coast defense becomes helpless the instant the stock of ammunition is exhausted.

Our entire investment in national preparedness will be wasted money, if it does not include the manufacture of nitric acid from the air on a scale to render us absolutely independent of foreign nitrates.

#### TARIFF

A reasonable tariff, if formulated upon rational lines, will be of much value in supporting our coal-products manufacture. Such a tariff would divide these products into three classes according to their degree of advancement in manufacture, and would levy duties proportionate to this degree. The classes would be, first, crude products; second, intermediates; third, dyes, pharmaceuticals and highly refined products. The duties should be: On crudes, 10 per cent ad valorem; intermediates, 20 per cent ad valorem, and dyes, 30 per cent ad valorem.

If a specific duty be included it should be at the rate of  $3\frac{3}{4}$  cents per pound on the intermediate class and  $7\frac{1}{2}$  cents per pound upon dyes and pharmaceuticals. There should be no specific duty on crude products.

The free list should include coal tar, coal-tar pitch, creosote oil and mineral acids. Natural indigo and other natural dyes of vegetable or animal origin should be placed with synthetic dyes, in class three.

Class 1—crude products—should comprise a small list. It should be described as: all crude products of coal produced through destructive distillation of coal, or otherwise, and not refined by more than one distillation, nor refined by any process other than distillation, nor refined nor produced by synthesis; such products being crude light oils, benzol, toluol, xylol, cumol and naphthalin, crude-tar acids containing less than 80 per cent pure-tar acids, and all other products from coal not otherwise specially provided for, and not medicinal and not colors or dyes, the duty to be 10 per cent ad valorem.

The second, or intermediate class, should include all products manufactured from those of the crude products class, and all so-called intermediates, not colors nor dyes nor pharmaceuticals nor medicinal products, such products being phenol, cresol, aniline, anthracene, etc.—duty 20 per cent ad valorem and  $3\frac{3}{4}$  cents per pound specific.

The third class should include all colors or dyes derived from coal, including indigo, natural and synthetic, and alizarine—dry or suspended in water—and dyes obtained from indigo or alizarine, and all products derived from coal, which are used for pharmaceutical or medicinal purposes, or other purposes—duty 30 per cent ad valorem and  $7\frac{1}{2}$  cents per pound specific.

Natural indigo and all dyes, pharmaceuticals and medicines, and all other products derived from natural sources of vegetable or animal origin, and which are used interchangeably with similar products derived from coal, should be included in class three.

#### ANTI-DUMPING CLAUSE

There should be an anti-dumping clause to prevent unfair competition instituted for the purpose of destroying American industry. A dumping clause must be drafted with utmost care and its working tactfully handled. If it be too drastic, or if handled without

good judgment, it will become worthless, or worse, because foreign countries, in retaliation, will inflict the anti-dumping penalty upon any American manufacturers who may sell their goods in those countries at lower prices than in the United States. We cannot afford to take any chances with American industry now when our export trade in manufactures is becoming better established than ever before in our commercial history.

#### COMPULSORY WORKING OF PATENTS

Compulsory working of patents looks attractive in theory. In practice there has been nothing in the history of the coal-products industry which could have been changed or improved by it to the slightest degree. Compulsory working of patents has been tried in England, France and Russia as recently as 1907, and proved a total failure in those countries.

As stated by the German authority, Prof. Otto N. Witt, "the success of a coal-tar-dye factory is no longer dependent upon the careful guarding of factory secrets as in the past, but upon a systematically arranged plant and the proper distribution therein of the work to be performed, and above all upon skillful commercial management, both within and without the factory."

#### LACK OF TECHNICAL COMMON-SCHOOL EDUCATION

Lack of technical common-school education is a further disadvantage from which we suffer. Our system of early nineteenth-century education includes no technical or trade schools, by which in Germany the entire population is perfected in twentieth-century methods for earning their living in twentieth-century industries. In consequence American labor does not give effective attention to its job, and it is extremely difficult to secure labor in the United States which will give competent attention to the delicate chemical manufacturing operations of the coal-products industry.

In summary, the essentials for creation in the United States of a complete industry in the manufacture of products derived from coal are: Co-operation of the American acid and alkali manufacturers with the coal-products industry; co-operation of the American consumers with American products through long-term contracts to assure us the American market; establishment of the industry on a peace scale big enough to make it a fundamental factor in national defense; establishment on a profitable commercial basis of the manufacture of nitric acid, by fixation of atmospheric nitrogen; nationalization, or rather internationalization, of the industry to insure a balanced world market for all by-products; development of a system of twentieth-century common-school and technical-school education, and finally maintenance of a rational tariff.

That a larger coal-products industry will be established in the United States is certain. The degree to which it attains perfection will be in proportion to the extent with which these requirements for its profitable operation are provided.

Semet-Solvay Company,  
Syracuse, N. Y.

The Canadian Mining Institute will meet in annual session at Ottawa, March 1, 2 and 3, 1916. Professional and business sessions will be held on the first two days, and the annual dinner will be held on the evening of the second. The third day will be devoted to a series of excursions to points of interest, including the mint, the Victoria Museum, and the Government ore-testing laboratories. The professional sessions will be marked by several important symposiums on various subjects, among which are flotation and mining education. Prof. J. W. Bell will present the results of ore-crushing experiments at McGill University.



## Presentation of Perkin Medal to L. H. Baekeland

### Report of Proceedings, Presentation Speech by Dr. Chandler, Speech of Acceptance by Dr. Baekeland

On the evening of Jan. 21, in Rumford Hall of the Chemists Club of New York, amid beautiful decorations of roses, in a lavish setting of flags, bakelite products and velox photographs, before a very large, enthusiastic and representative assemblage, the Perkin medal was formally presented to Dr. L. H. Baekeland.

Dr. W. M. M. GROSVENOR, chairman of the New York section of the Society of Chemical Industry, presided. In his introductory remarks he sketched the scope and the history of the Perkin medal, which is annually awarded for most distinguished service in industrial chemistry by a joint committee of the different American chemical societies.

Dr. CHARLES F. CHANDLER, the beloved dean of chemistry in America and senior American past-president of the Society of Chemical Industry, made the formal presentation speech in his happiest mood.

Dr. L. H. BAEKELAND accepted the medal in a few words of thanks, full of deep feeling.

Two deliciously informal speeches were then made by men with whom Dr. Baekeland had been closely connected in his professional career. Mr. RICHARD A. ANTHONY who had given Dr. Baekeland his "first job" in America as a photographic chemist, expressed his delight of having finally found out the secret of velox—that washing can be overdone. He recounted various instances from later life in which he had consulted Dr. Baekeland, in different chemical projects, the advice given always turning out right.

Mr. ELON HUNTINGTON HOOKER, president of the Hooker Electrochemical Company, followed with an exceedingly clever speech, recalling the early days when the Townsend cell was being tested out on a semi-commercial scale:

In this Republic, when offering the highest laurels, we delight to trace back the connection, with humble associations, of him we honor. So it is characteristic to wish to link this occasion with the amusing, but, none the less, highly dramatic and serious incidents of Dr. Baekeland's intervention in the original testing of the Townsend Process in commercial units. Imagine, if you can, a wing of the Edison power station in an altogether disreputable section of Brooklyn. Two full-size Townsend cells, erected with necessary supply tanks, exhaust chimney, etc., producing chlorine in juxtaposition to the valuable generating units of the Edison Company. Upon these the lighting and transportation conveniences of the "city where we sleep" are dependent.

Picture further, three young men, who did not know chlorine gas from ottar of roses, or caustic from lemon ice, but of undoubted bravery, assisted by negroes whose only aim was Saturday night's pay and the hope of a possible bleaching,—picture them, guided sporadically by Townsend and Sperry, but presided over, their drooping spirits revived, and their hope of heaven determined, by the genius of Baekeland. He, you understand, had just been rescued from the depths of photographic invention, with its spirit-dulling materialistic opulence, and uplifted to the rare delights of electrolytic research—that shadowy borderland between pure science and commercialized industry where

mathematics and chemistry join hands in the great unknown.

Here our friend held forth long hours in shirt-sleeved efficiency, while his social reputation became tainted, his domestic status strained, and his short nights of peace in Yonkers, even in Harmony Park, were rent with agonized appeals for help from Brooklyn at 3 o'clock in the morning: "Cell No. 1 has broken down; the place is full of chlorine gas; we are all out in the street; the Edison boss says his \$100,000 generators are being eaten by a green substance. What shall we do?" Answer:—punctured with picturesque speech: "Start it up, of course. I will be over before breakfast."

Or again: "Cover cell No. 2 has blown off from hydrogen pressure. What would you do?" Answer:—in voice choked with sleep, or deep emotion, and clothed in pajamas: "Put on a new cover and have the darkey sit on it until I can get over in the morning."

That Brooklyn equipment had been timed with all the nicety of shrapnel. Exhaust fan and stovepipe chimney resisted the chlorine until a mere shell, and then, like the "wonderful one hoss shay," crumbled into a mass of iron dust the last day of the test. The Edison janitor shoveled us into the street and, like a true homeopath, disinfected the place from garret to cellar with drums of chloride of lime.

Mr. Hooker then spoke of Dr. Baekeland as a man. "You all know his multifarious activities; a helping hand here, a word of inspiration there, a cheery hand grasp, with wisdom dissolving away technical difficulties; speech clean, from a heart that thinks no ill of others, the standard of professional ethics carried high where all can approve, and a breadth of scientific grasp

and knowledge which illumines whatever his swift mind plays upon. We, his friends, lack the proper perspective to do him and his work justice. Time alone can furnish that."

In conclusion Mr. Hooker pointed out how Dr. Baekeland "has put his faith and his life into American institutions, until he stands, known of all men, as one of the best Americans—one whose enthusiasm, patriotism, and love of his adopted country takes us back to the Americans of an earlier day. It is thus I like best of all to think of him."

The proceedings were concluded by Dr. Baekeland's long and very interesting, instructive and suggestive formal speech of acceptance which truly fascinated his audience.

Twice during the proceedings Mrs. Baekeland's name was mentioned. First, when Dr. Grosvenor in his opening speech referred to the floral decorations "for which we have to thank one who has had very much to do with the genial success of Dr. Baekeland—Mrs. Baekeland." Again, when in his address of acceptance Dr. Baekeland spoke of his university days in Belgium, he said that one of the most fascinating discoveries he then made was the fact that his senior colleague in the chemical department had an unusually attractive daughter and that this discovery led a few years later to the most interesting and successful experiment of his life.



L. H. BAEKELAND

We herewith publish in full the two formal addresses of Dr. Chandler and Dr. Baekeland:

### Presentation Address

BY PROF. C. F. CHANDLER

Mr. Chairman and Brother Chemists:—It is my privilege and very pleasant duty, as Senior Past-President of the Society of Chemical Industry, residing in this country, to present to Leo Hendrik Baekeland, B.S. and D.Sc., the tenth impression of the Perkin Medal, in recognition of his most original and valuable work in applied chemistry.

Dr. Baekeland was born in 1863 at the old Flemish city of Ghent, where he received his early education. He passed through the elementary schools, the Athenaeum, a Government High School, where he prepared for the University, and the Ghent Municipal Technical School, which resembles our Cooper Institute.

In 1880 he entered the University, where he studied various natural sciences, specializing in chemistry. Although the youngest student in his class, seventeen on entering, he promptly won his degree of B.S. and later, when 21 years old, the youngest graduate, he received his degree of Doctor of Science, passing his examinations with the highest honors.

Dr. Baekeland must have been as industrious while a student, as he has been since he graduated, for from the age of seventeen he supported himself entirely by tutoring and as lecture assistant.

Later he was appointed assistant professor, and in 1889 associate professor at the University of Ghent.

In the meantime, in 1887, he had been appointed professor of chemistry and physics at the Government Normal School, then existing in the city of Bruges.

In a competition among the alumni, who had graduated from the four Belgian universities during a preceding period of three years, he was awarded the first prize in chemistry, by a jury of the senior professors of chemistry of the four universities: Theodore Swarts and W. Spring for the Government Universities of Ghent and Liege; P. De Wilde and Louis Henry for the Universities of Brussels and Louvain. The president of the jury was Jean-Servais Stas, best known by his classical researches on the atomic weights.

This prize, besides a gold medal and other rewards, entitled him to a traveling scholarship, by which he was enabled to visit some of the universities in England, Germany and Scotland, and to make a trip to the United States in 1889.

I have given you these details of Dr. Baekeland's early life, because I believe few, if any, of you were familiar with them; because they are most creditable to him, and show his personal character, and because I knew he would not disclose them himself.

Before leaving Ghent, he had become deeply interested in photography. Since the early eighties Ghent had become a center of the new industry of dry-plate manufacturing, started there by Dr. Van Monckhoven.

Dr. Baekeland was an enthusiastic amateur photographer, and had followed every step of the new processes, with the result that he acquired some reputation in this new branch of chemical industry.

On his arrival in New York, he became acquainted with Richard A. Anthony of E. and H. T. Anthony & Co., with whom I had been associated for some time as editor of their photographic bulletin. Richard Anthony brought us together, and I think it was a case of love at first sight, for we have been the very best of friends ever since.

The Anthony firm, which later joined the Scoville Company in establishing the Ansco Company, had engaged in the manufacture of photographic films and bromide paper, and they offered Dr. Baekeland an ex-

cellent position as chemist in their factory, an offer which he promptly accepted, deciding to remain in the United States.

The Minister of Education of Belgium, in accepting his resignation, paid him the unusual compliment of authorizing him to retain the honorary title of "Associate Professor at the University of Ghent."

After two years, he left the Anthony firm and established himself as a consulting research chemist, and devoted himself to developing several chemical processes which he had devised.

In 1893, in partnership with Mr. Leonard Jacobi, he founded in Yonkers, the Nepera Chemical Company, where he started very modestly the manufacture of various kinds of photographic papers. One of these papers, which was called "Velox," has since earned a great reputation as a photo printing paper.

Dr. Baekeland had worked to perfect this paper as far back as 1883, while he was still a student in Ghent, but its importance as a possible subject for a commercial enterprise did not become apparent to him till much later.

Silver-chloride emulsions had been proposed and described in 1891 by Eder and Pizzighelli, but their process was carried out along the same general lines as silver-bromide emulsions, namely, precipitation and ripening, followed by washing to remove the soluble salts resulting from the reaction.

Baekeland had found that as far as chloride of silver emulsion is concerned, the last two operations, although they increased the sensitiveness of the emulsion, had a disastrous influence on the tone and general gradation of the image, specially in the shadows.

He had discovered that in order to keep these desirable qualities it was necessary to produce chloride of silver in a special colloidal condition, which is easily disturbed by any after treatment of the emulsion, as for instance, "ripening" or "washing."

By committing an act of "photographic heresy" in omitting the washing entirely, Baekeland found he could make a variety of colloidal silver-chloride which was relatively insensitive to the yellow rays of the spectrum, and therefore could be manipulated by candle or gas light, if not brought too near.

This made the paper incomparably inferior to bromide paper, or ordinary chloride of silver paper, as far as speed is concerned.

But Baekeland realized the important fact that by exposing quite close to the artificial light, and developing the image at a safe distance (a few feet) the apparent defect could be turned to a great practical advantage.

But the process had to be studied in all its endless details of manufacture before it could be carried out on a large scale, so that it could be standardized for use by the photographic public, which was no easy task.

The paper was put out in the trade under the name of "Velox," and met with very scant favor at first; in fact, it took years of education and hard work before the value of the process was fully recognized.

Then as soon as the first indications of success were apparent, several competitors started in the same field.

But after the value of the process was clearly recognized, it gained rapidly in popularity, and in 1899 the Eastman Kodak Company offered to buy out the entire business enterprise on very liberal terms, which were promptly accepted.

This relieved Dr. Baekeland from all further commercial worries, and placed him in a position in which he was free to live the life he had always ardently desired; in which he would be able to devote his time and energy to study and research, free from school, university and business cares.



Dr. Baekeland next turned his attention to electrochemistry. It was a new branch of chemical industry scarcely known in his early student days. Its field was limited then to the electro-deposition of a few metals from aqueous solutions, such as copper, nickel, silver and gold.

He was very much impressed by the wonderful expansion of the applications of electricity for chemical purposes in recent years, especially in the United States.

Charles M. Hall, a Perkin medalist, had brought out his beautiful and simple process for extracting aluminum from alumina, in 1886, and had given a practically new metal to the world to replace copper, tin and zinc in many arts.

Hamilton Y. Castner, a Columbia boy, had invented, in 1890, his simple process for making sodium a commercial metal, and simplifying the preparation of some of its most valuable compounds, as cyanide and peroxide; and in 1892 his ingenious process for making pure caustic soda and chlorine from salt.

Edward Goodrich Acheson, a Perkin medalist, in 1892, had discovered carborundum, and devised a simple process for producing it in unlimited quantities, and in 1895 had devised his process for the manufacture of artificial graphite, which he followed later, in 1906, with the invention of that remarkable and useful substance, "deflocculated graphite."

Thomas L. Willson had, in 1899, devised a process for producing in unlimited quantities crystalline calcium carbide, which by the action of water creates acetylene gas, and by the action of nitrogen from the atmosphere, produces the new and most valuable atmospheric fertilizer, "calcium cyanamide."

There are two facts which make me linger here with pleasure: every one of these inventions was made by an American chemist, and every one of them resulted in the establishing at Niagara Falls one or more large works, where the inventions are utilized by the use of electricity developed by the waters of Niagara.

These industries are financed, and most successfully worked by the Aluminum Company of America (Hall's aluminum); the Niagara Electro-chemical Company (Castner's sodium and cyanides); the Castner Electrolytic Alkali Company (Castner's caustic soda and chlorine); the Carborundum Company (Acheson's carborundum); the International Acheson Graphite Company (Acheson's graphite and deflocculated graphite), and the Union Carbide Company (Willson's calcium carbide).

Who can question the ability of American chemists to make original researches and devise new and useful processes? These are not all, by any means; they are merely examples which I have selected because I am most familiar with them.

Dr. Baekeland was very much impressed by these developments, and decided to enter the electrochemical field. So he spent a winter at the Technological Institute at Charlottenburg, near Berlin, in the electrochemical laboratory, to freshen up his knowledge of the subject.

On his return to America he equipped a modest private laboratory on his grounds at Yonkers, and provided it with a few electrochemical appliances for further study.

His work drifted in many other directions, but about that time Mr. Clinton P. Townsend had just invented his now famous electrolytic cell, for producing caustic soda and chlorine from salt. Baekeland was requested by Mr. Elon H. Hooker to take the direction of the work preliminary to the industrial development of this invention. This he did in company with the inventor and several other skilled experts.

The work finally resulted in the formation of the

Hooker Electrochemical Company, and the erection at Niagara Falls of one of the largest and best equipped electrochemical plants in the world, with which he is still connected in an advisory capacity. In this connection he took out his first two patents, "apparatus for regenerating electrolytes," and "an electrolytic diaphragm and method of making same."

#### BAKELITE

Dr. Baekeland's crowning work is the solving of the mysteries involved in the action of formaldehyde upon phenols, and giving to the world the new material "bakelite."

Bakelite is a so-called condensation product of phenol—or carboic acid—and formaldehyde. Instead of phenol, its homologues, cresols or other phenolic bodies can be used. Instead of formaldehyde, other substances which have the same functions may be utilized, as, for instance, methylal, paraform and hexamethylenetetramine.

It should be well understood that formaldehyde in reacting upon phenol does not necessarily give bakelite. Quite to the contrary, it is only under very special conditions, now well established by the published research work of Baekeland, that this substance can be obtained.

In fact, when formaldehyde is let to react on phenol under ordinary conditions, almost anything may happen but the formation of bakelite.

There are very few examples where the same two substances, reacting upon each other, can give such a variety of products. For instance, a nicely crystalline substance, called saligenin, or oxybenzyl-alcohol, found in the willow-tree (*Salix*), may be the result. This substance has been used in medicine, and is known also as diathesis.

In other cases, a resinous material is formed, but it has no specially new properties and is very similar to cheap, natural resins. For instance, it can be melted and dissolved rapidly just like any other natural resin, and neither its hardness nor other general properties give it any special claim above the natural resins.

This is the substance which has been called novolak, and which has been prepared by Blumer and others; it has never found any serious applications as such, although at one time it was expected that it would be useful as a shellac substitute, when the price of shellac was unusually high.

It is generally known that as far back as 1872 Adolf Bayer and his pupils (*Ber.*, 5, 1095; 19, 3004; 25, 3477; 27, 2411) showed that it was possible to obtain condensation products of *aldehydes* and *phenols*. These experiments, at this time, were not conducted with formaldehyde, because formaldehyde, as such, was not obtainable, so the reactions were mostly conducted either with the methylen representatives of formaldehyde or with the then available acetaldehyde.

The substances studied at that time varied considerably in character and embraced more particularly certain crystalline, well defined products. Now and then some uncrystallizable substances were obtained, but no special attention was paid to them, nor had they much in common with the present product, except that they had a resinous appearance.

About 1891, formaldehyde was put on the market as an article of commerce, and Kleeberg (*Annalen*, 263, page 283, 1891) tried to repeat some of the work of Bayer by using formaldehyde, in presence of strong hydrochloric acid. He thus obtained a worthless, irregular mass, which he attempted to purify by the usual methods and bring to a constant composition, but he did not succeed, so he dismissed the whole subject and continued his studies of phenolic condensation products along other lines which enabled him to prepare well

defined crystalline substances which have nothing to do with the present subject, except the origin of the raw materials.

Others, like Smith, Luft and Story, took up the same subject, using formaldehyde, endeavoring to master this reaction either by the presence of solvents, which were partially eliminated afterward, or by the introduction of foreign substances like camphor. But none of these processes developed into anything on which an industrial enterprise could be founded with any chance of success.

In the meantime, Blumer and De Laire had described methods by which formaldehyde and phenol could be made to produce, with certainty, special resinous substances which were entirely analogous to the natural resins, like shellac, copal, etc., of which they had practically all the general properties; that is to say, they were fusible, they could be melted, they could be dissolved in suitable solvents. These processes were calculated carefully to avoid the formation of anything but these fusible and soluble products, on which they built great hopes as possible substitutes for shellac.

If the methods of preparation described by these inventors are not carefully followed, then it happens frequently that disturbing side products are produced. The latter, instead of being easily fusible and soluble, are irregular masses of the Kleeberg type containing variable amounts of infusible and insoluble substances which are of no value for further purposes, because you cannot do anything with them after they are once formed. These are exactly the substances which Kleeberg had rejected on account of their negative properties.

This was the state of the art until Baekeland made the disclosure of his own work. He was particularly attracted by the failure of Kleeberg and hoped to find a suitable solvent for his worthless product. It occurred to him that if he could find a solvent for this material he would be able to make a varnish superior to all existing varnishes. The difficulty was to find the solvent.

His assistant, Mr. Nathaniel Thurlow, felt very skeptical about it and pointed to the unsuccessful attempts of others, after trying most of the available solvents. The fusible, soluble resins of the Blumer and De Laire type seemed considerably more attractive.

But Baekeland took the point of view that their qualities were not better than those of the natural resins. In fact, in practical tests on a large scale, he had found that in many respects their qualities were inferior to those of shellac, which, furthermore, could be purchased at a more advantageous price than the cost of production of these synthetic resins.

So he concluded to purchase or prepare further solvents of every kind so as to determine whether he could not do something with the substance of Kleeberg, and finally, after many renewed attempts, he had to give it up as a hopeless task.

Then he changed his tactics. He reasoned that if nothing could be done with the substance after it was once produced in a flask or any other vessel, he should attempt to carry out the reaction so as to generate the substance right on the spot where he wanted it. For example, he thought that if he could make the synthesis inside of the fibres of wood by injecting first the two reacting raw materials, and then start the reaction, he might be able to incrust the fibres of the wood with an unusually hard and inert substance, and give to the wood new properties.

This was easier said than done. He encountered endless difficulties. Certain classes of wood, specially the higher grades, instead of becoming harder, became softer. He also noticed that chemical reactions in these

capillary conditions proceed in a very different way than in a flask or other container, for the reason that the chemical dynamics in capillary spaces are considerably disturbed, so that the reaction which may terminate rapidly and completely in a wide vessel, will be considerably hampered when the mobility of the reacting molecules is disturbed by capillary conditions.

He also perceived that, just on this account, the carbo-lic acid, before it had time to react upon the formaldehyde, had every opportunity for destroying the fibre. He concluded that in order to have any success, he should either be able to speed up the reaction by some special means, or he should find a way whereby he could partially start the reaction outside of the fibre of the wood in a flask, and finish it afterward within the tissue of the wood, after injection.

This led him to a long systematic investigation, when he tried to study all the different factors of the reaction. When he was through with this line of research he had established practically all important facts on which is based the foundation of the present industrial processes of bakelite.

He found that under certain conditions he could dissect the reaction in different succeeding steps, where one of the first steps was the production of a certain intermediary substance which, although it had the general appearance of a resin on account of its brittleness, its solubility and its fusibility, differed radically from the natural resins by the fact that as soon as he heated it at a certain temperature above its melting point, it changed into an entirely different body incomparably harder and stronger than the original resinous material, and which, furthermore, looked like natural amber although it was much stronger than amber, and had another advantage over amber or similar resins, in the fact that it did no longer melt if heated, and that it was insoluble in all known solvents.

He also established the fact that in the different reactions which engendered this substance, there is one phase where polymerization occurs and that this phase is accompanied by self-heating, which brings about a considerable rise of the temperature of the mass, so that whenever any attempt is made to hasten this part of the process which produces hardening, the self-heating becomes so exaggerated that gaseous products are evolved, which blow up the mass and cause porosity, which makes it worthless. In order to offset this, he introduced, besides other means, the use of a very strong counter-pressure during the period of polymerization.

He discovered also the important fact that the presence of ammonia, or another base, in suitable proportions, will surely make the reaction go the right way toward the production of the infusible product, while with the presence of an acid, the formation of permanently fusible resins will be favored in case the amounts of carbo-lic acid are preponderant; that furthermore, the use of a suitable base in proper quantities gives an easy means of controlling the reaction at whatever phase is desirable. From then on, it became possible for him to avail himself of practical means for preparing, as a starting point, an initial condensation product which was still fusible and plastic, and do with it whatever he pleased while it was still in that initial condition. For instance, he could mold or form it or dissolve it, and then afterward, under the action of heat, polymerize and harden it to the final condition of maximum hardness and strength, where it is no longer fusible or soluble after it had acquired its permanent shape.

The initial bakelite is designated usually as bakelite A; before it is polymerized, it dissolves and melts to a liquid; but this liquid has the strange property of



"freezing" when sufficiently heated and then afterward can never again melt or dissolve; it has been "polymerized" into bakelite C.

It should be pointed out here that ammonia, in conjunction with formaldehyde, gives a chemical which is called hexamethylenetetramine, and that the action of ammonia in presence of formaldehyde in this process is entirely similar to that of the use of hexamethylenetetramine.

It was found also by him that the mechanical properties of these infusible condensation products were enormously improved by the introduction of fibrous substances, as for instance, wood fibre or asbestos. All pulverulent fillers which are successfully used in conjunction with other plastics, instead of improving bakelite, make it worse. This is due probably to the fact that bakelite, although it has an unusually high tensile strength, has a relatively low degree of elasticity which makes it sensitive to impact and shock. The introduction of fibrous materials into bakelite makes it enormously more resistant to shock than the pure article.

Many other facts were established by his work. For instance, it was demonstrated that among the homologues of phenol, it was not indifferent what kind of homologues is used. It so happens that ortho-cresol tends towards the formation of fusible products of low strength. Para-cresol also gives condensation products of very inferior qualities, while meta-cresol, or mixtures of meta-cresol and para-cresol, give the best product. This enables the use of some of the more available cresols, instead of expensive phenol.

He not only pointed out unmistakable methods for producing every time, at will, either a fusible or an infusible resin, but he gave the explanation why in one case one substance and in another case, a different one was obtained, when starting from the same raw materials. He established the theoretical relations and parentage of those different substances, all derived from the same raw materials and yet so different in their properties and technical uses. In this way, he established the relation between the crystalline product saligenin (oxybenzylalcohol) contained in the willow tree and how it is possible ultimately to convert it, at will, either into the fusible resin of the Blumer type, or into bakelite, by submitting it to further chemical reactions.

To sum up: Before he had published the results of his work, there existed not a single industry, nor a single application of any importance based on these condensation products. Since he has published his patents and read his papers before the American Chemical Society, there have been started here and in Europe numerous factories where these processes are used for the most varied purposes, ranging from the manufacture of a billiard ball to that of a wireless telegraphic apparatus; from the manufacture of a self-starter for automobiles to that of transparent fountain pens, this range of varieties embracing such articles as switchboards for battleships, moldings for kodaks, phonograph records, casings for instruments of precision, armatures and commutators for dynamos and motors, telephone receivers, railroad signals, grinding wheels, umbrella handles, buttons, cigar holders and pipe stems, articles of ornament, etc.

The General Bakelite Company has a very complete plant at Perth Amboy, where the raw materials are made; there are a large number of licensees in the United States; bakelite plants in Germany, France and England; and several factories in Europe where bakelite goods are manufactured under license, for example, two bakelite button factories in Germany and one in Russia.

It is absolutely impossible to tell the story of "bakelite" with any completeness in the time allotted to me, and I must refer you to Dr. Baekeland's articles and patents, where you will find everything fully set forth.

I have prepared a complete list\* of the United States patents, arranged in the order in which they were applied for, as that order will enable you to follow chronologically this stupendous investigation.

There are many additional patents which have been allowed but not yet published, and many more which are now before the Patent Office.

It was at first thought by some persons that some of the early investigators, beginning with Adolf Bayer, whose names I have already mentioned, must have anticipated Dr. Baekeland in his discoveries and inventions. This is not the case; Dr. Baekeland's inventions, as described in his patents, are not anticipated.

The subject was most thoroughly tried out in the United States District Court, Eastern Division of New York, before Judge Chatfield, who rendered his decision in Dr. Baekeland's favor, in a most elaborate and lucid opinion, covering twenty pages of The Federal Reporter. His Honor clearly pointed out step by step the radical differences between the work of Baekeland and each one of the prior writers and patentees.

In closing I will call attention to the distinctions which Dr. Baekeland has had showered upon him, in recognition of his scientific standing and achievements in the domain of industrial chemistry: President Chemists' Club, 1904; vice-president Society Chemical Industry, 1905; chairman N. Y. Section American Chemical Society, 1908; president American Electrochemical Society, 1909; president American Institute Chemical Engineers, 1912; president Inventors' Guild, 1914. Official U. S. delegate to International Congress of Chemistry, London 1909; president Section of Plastics, International Congress of Chemistry, New York, 1912; first Chandler Lectureship, School of Mines, 1914; member Naval Consulting Board of United States, 1915. Nichols Medal, 1909; John Scott Medal, 1910; Willard Gibbs Medal, 1913; Chandler Medal, Columbia University, Fiftieth Anniversary School of Mines, 1914.

Leo Hendrik Baekeland, Doctor of Science, my dear friend: It gives me the greatest pleasure, as the representative of the affiliated chemical and electrochemical societies, to place in your hands this beautiful Perkin Medal, as a token of the appreciation and affection of your fellow chemists.

\* \* \*

#### Address of Acceptance of Perkin Medal

BY DR. L. H. BAEKELAND

Mr. Chairman, Ladies and Gentlemen:—In accepting the great honor you are willing to bestow upon me, I realize at the same time how many of my fellow chemists have achieved much better work than anything I ever attempted. On this account, my feeling of gratitude toward you changes entirely into a sentiment of profound humility and arouses in me the ardent desire of endeavoring to do better in the future. Should I not live up to this resolution, then every time I shall look upon this medal, it will appear to me as a symbol of reproach instead of a token of merit.

And now, what shall I say further on this occasion? So much has already been told about me this evening that, if I could drop the whole subject right at this

\*Dr. Baekeland's U. S. patents are 844,314, 1906-7; 855,221, 1906-7; 949,671, 1907-10; 942,699, 1907-9; 942,852, 1907-9; 954,666, 1907-10; 942,809, 1907-9; 942,808, 1907-9; 1,057,319, 1907-13; 942,700, 1907-9; 939,966, 1909-9; 1,054,265, 1909-13; 941,605, 1909-9; 1,019,408, 1909-12; 1,160,362, 1909-15; 1,160,365, 1909-15; 1,038,475, 1909-12; 1,146,045, 1909-15; 957,127, 1909-10; 1,057,211, 1907-13. The patents are given in the order of their application, the first date following the patent number is the year of application and the second is the year of issue.

point and go quietly home, I should feel intensely glad and relieved.

But the Perkin Medal Committee urges me to take this opportunity for explaining some of my experience as far as it relates to the handling of problems connected with new chemical enterprises.

Therefore, I can spare you a repetition of technical details about my work, which you have heard abundantly on other occasions, and which are now available in the chemical literature. I shall thus try to make this occasion serve a better purpose by presenting my point of view in relation to the chemical development of this country, and I hope that by the time I am through, I may have convinced some of my younger fellow-chemists that a reasonable measure of success in their chosen career is not such a difficult matter after all.

#### PRACTICAL LIFE AS A COMPLEMENT TO UNIVERSITY EDUCATION

Reference has been made by Professor Chandler to my early training. I feel very grateful for the excellent opportunities of education I had at the University of Ghent. I should state, however, that my real intense education only began after I had left the university, as soon as I became confronted with the big problems and responsibilities of practical life; this education I received mainly in the United States, where for twenty-seven years I was thrown in contact with so many varied subjects. I hope to remain until I die, a post-graduate student at that greater school of practical life, which has no fixed curriculum and where no academic degrees are conferred, but where wrong petty theories are best cured by hard knocks. There was a time in my life when, as a young teacher of chemistry, I was just as cock-sure as some of my older colleagues that everything was as simple as it appears in the text-books. This lasted until I tried to make bromide of silver for commercial purposes in the preparation of photographic emulsions. Stas had already published the fact that there were three or four different varieties of bromide of silver, all of exactly the same chemical composition, yet differing in their physical properties. By the time I got fully engaged in the manufacture of silver-salt products for photographic purposes, I had come to the conclusion that instead of three or four varieties of bromide of silver, there existed perhaps a hundred varieties, but that of those hundred varieties, there was only one which might probably keep me from the poorhouse and assure me success as a manufacturer. And yet, until then, that unexciting chemical reaction which produces bromide of silver and which in our text-books is expressed by such a simple chemical equation, always had appeared to me as hardly worth while of further investigation. By and by, I began to look at chemical phenomena from quite a different standpoint, and I well remember the day when I reasoned to myself as follows:

"Here is one of the very simplest of all chemical reactions, so simple that any chemist hardly wastes any time over it, and yet it involves phenomena so intricate, so varied in scope and effect, that we have not yet found the proper means to fathom them. Here is bromide of silver, freshly precipitated in the dark; it has the property of not darkening if brought in contact with a reducing agent—a developer—and yet the mere action of light, even for only an infinitesimal fraction of a second, brings about such a profound alteration in its constitution that henceforth it will blacken and set silver free if treated with a reducing agent, and thus produce a photographic image. Furthermore, this bromide of silver, before and after it has seen the light, is exactly the same, as far as we can decide by chemical

analysis or any of our other clumsy means of observation. Suppose now that the human race were not provided with the sense of eyesight—just as we probably are missing several other senses—we would forever remain unaware of that peculiar effect of light on silver bromide or on chemical reactions in general."

This gave me one of my first warnings not to accept any chemical explanation in too simple terms, and engendered in me the evergrowing belief that the very plainest chemical reactions are incomparably more complicated than our hasty generalizations in text-books lead us to believe.

It thus became my good luck that my early struggles with photographic problems cured me of too much confidence in easy explanations of chemical phenomena and made me lose somewhat that youthful overabundant faith in class-room theories. I suppose my experience is very similar to that of many an industrial chemist who has had to learn by sheer experience, that after he may think he knows everything on a certain subject, he is constantly confronted with endless matters of detail which at first seemed so trifling, alongside the broad lines of the subject, as to be unworthy of the attention of the theoretical chemist. And yet it is these details which frequently determine whether the practical solution of a problem is possible or not—whether the ruin or success of a chemical enterprise is in sight.

#### TOO MANY IRONS IN THE FIRE

Nor was it all plain sailing in my early days here in this country. Like so many others, I committed the mistake of scattering my attention on too many subjects at the same time. After I left the Anthony firm, I tried to work out, without sufficient financial means, several half-baked inventions, the development of each of which would have required a small fortune. Fortunately for me, I was taken out of this muddle and shaken to my senses by a very severe illness which nailed me to bed for several months. While I was hovering 'twixt life and death, with all my cash gone and the uncomfortable sentiment of rapidly increasing debts, I had abundant time for sober reflection. It then dawned upon me that instead of keeping too many irons in the fire, I should concentrate my attention upon one single thing which would give me the best chance for the quickest possible results.

Among many other matters, I had an electrolytic process for extracting tin, a safety explosive, and a new photographic paper. The tin process had lost all its charms since the swampy meadows of New Jersey, where I was carrying out my experiments, had brought me almost within close acquaintance of the undertaker. Nor did the manufacture of explosives appeal much to me after I had been for so many months in the hands of surgeons and physicians; so I turned to my old love, photography, ready to manufacture some new kinds of photographic paper.

#### THE HISTORY OF VELOX

I was lucky enough to make the acquaintance of Mr. Leonard Jacobi, of San Francisco, who was willing to risk some of his cash in my venture. He knew nothing of chemistry, nor of any technical matters, but he was a generous-minded, cheerful and very industrious man, who furthermore honored me with his implicit confidence. Although much of an idealist, he was in business matters very sober-headed and very careful and conscientious towards all the immediate problems before him, and I owe it to the excellent example of his common sense that I learned some of the practical rules of business life which afterwards came into good purpose in my future career.



Do not imagine that from the beginning of this enterprise everything went smoothly. Quite to the contrary. As luck would have it, we started this venture just at the very worst time, in 1893, during the famous business panic, when so many of the industries of the United States went under. In this instance, our salvation was that we had started on a modest scale and that whatever disadvantageous conditions we encountered, or whatever mistakes were committed, we could straighten up matters without too fatal a loss of capital.

We had more than our share of the usual technical troubles which accompany the starting of any new enterprise. It was found, for instance, that while we could make excellent paper in temperate weather, it became practically a hopeless task to do so in the hot summer days. Our sales were small and when we had any sales we were confronted with the problems of the climate and then our manufacturing methods were more or less like a gamble. This caused us considerable losses. The remedy seemed easy enough, so we tried to rectify the conditions of temperature by artificial cooling, as others had done. But this had not the required effect and new disappointments confronted us.

After awhile special scientific investigation disclosed the fact that the troubles were not due so much to the factor of temperature as the moisture in the air. This led us to install a refrigerating system over which the air could be drawn first so as to extract its moisture by precipitating it as ice, after which the dried air could be sent over heated pipes so as to raise its temperature to the proper degree before it entered in the paper-coating machine. At that time this seemed a rather paradoxical method of operating, but to-day it has been adopted by several large manufacturers of photographic papers and films. It was only many years later that I heard of the Gayley process for blast furnaces where a similar method is used for insuring the steady dryness of the air in the smelting of iron.

Manufacturers in Europe, where the amount of moisture in the air does not vary to such an extraordinary extent between seasons, have scarcely any conception of what difficult manufacturing problems are encountered here in the United States where in winter the air is so dry as to cause electric sparks and abundant static electricity by friction, while in the summer months the air is often so saturated with moisture that any objects or machinery condense humidity on their surfaces at temperatures as high as 76 deg. F. But I believe that it is just on this account that in some industries American manufacturers have been compelled to solve with more thoroughness and with more effective means, the greater difficulties they encounter here in the varying climatic conditions; this also is the reason why some of our industries have reached a higher degree of development and perfection than the corresponding European enterprises. The humidity in the air during our hot summer season, aside from the manufacturing problems, is very hard on photographic prints. Photographs made with inferior processes may give prints which last many years if kept in Europe, but it frequently happens that the same prints deteriorate here in a few weeks in summer time.

In the early nineties and following years, this country was using more and more photographic printing methods which consisted of the so-called combined-bath processes, and by which toning and fixing of the image was produced at the same time.

At that time, practically all manufacturers of new sensitized paper advocated this rather easy process. Few, if any, hesitated to promise permanency of these prints, and this on the strength that such prints had been preserved successfully in Europe. A rather simple

test gave me a method of distinguishing which kind of photographic prints were most likely to fade. This test consisted in cutting a photograph in two and exposing one-half in a jar to the fumes of ammonium-hydrosulphide. This treatment, in a few hours, showed the same amount of fading as would have been produced under ordinary conditions after months or years.

Upon the result of these experiments I had based the manufacture of several sensitized papers, which I could unhesitatingly recommend as giving permanent prints. One of these papers we called Velox, on account of the speed with which the prints could be made independently of weather conditions. In this process prints are exposed for a short time to artificial light and developed by the same light. I was firmly convinced that this process had a great future. Unfortunately, the public did not think so at all. In fact, it was very disappointing to notice how every photographer, amateur or professional, was wedded to the older processes and wanted to have nothing to do with the method about which I felt so enthusiastic.

To make matters worse, my very best friends did not hesitate to tell me that there was no chance whatsoever for this new method of printing, because they thought that it was so much simpler and easier to print in the sun, to which everybody was accustomed. I never was more impressed with the fact of how routine holds sway over this world; but I was rather stubborn in my point of view. I kept on trying to convince others how much simpler it is to be independent of sunshine. I shall never forget the endless correspondence I had with many people all over the country. I remember too well the kind of letters I used to receive and of which the following are some examples:

"I have tried every photographic paper in existence and I have been more or less successful with all of them until I tried yours, but it is hopelessly no good. You cannot blame my insuccess on faulty manipulation, because I am professor of chemistry at ——— College."

Or another: "I am a professional photographer of twenty-five years' experience. Your paper is the greatest photographic swindle of the age. You claim your method of printing is several hundred times faster than albumen paper, and here I have kept a print in the printing frame for several hours in the sun and I can hardly see a faint image."

It was only later on that I realized that most of those people *knew too much* about photography and, on this account, never gave themselves the trouble of even glancing at the printed directions which were sent to them; they were, like so many other people, past the age where they are willing to learn anything new.

Finally, our success came from the most unexpected quarters. A new generation of modestly beginning amateur photographers came up and began to give themselves the trouble of reading and following our printed directions. To the disgust of their more experienced friends, "who know it all," they began to show them excellent prints made on the new paper, better in several respects than experienced men in the profession had been able to produce with older processes. Nevertheless, it took considerable time before so many converts had taken up the new process that the grumblers and fault-finders were finally in the minority; it required four years of strenuous introduction before the business began to show some slight profit, notwithstanding the fact that all unnecessary expenses were carefully avoided. Two years more and the business enterprise began to prosper rapidly and then I was offered good cash for my interest in the business by the Eastman Kodak Company and I retired entirely from this field.

I should mention right here that if I had tried to sell

my processes at the beginning before they had been developed into a commercial paying enterprise, I could hardly have expected anything, because at that state my inventions would have been of little or no value beyond a mere gamble. It required the careful nursing of a business enterprise, and it was indispensable to establish firmly the process on a practical commercial scale before we were in a position to dictate our own price; even at that rate, the buyers took less risk than if they had obtained the process as a gift, before it had been worked out for several years and during several seasons. If I go into all these details it is merely as a hint to some of my friends who are apt to build castles in the air on processes which are not yet beyond their laboratory stage, and who are not willing to incur all the hard work and risk connected with their full development, and yet expect to obtain a large sum of money for their mere patent rights.

#### UNCERTAINTIES OF CHEMICAL PATENTS

Professor Chandler has already explained to you the underlying principles of the Velox process. I should mention that velox was never patented, except that its name is a trademark. At that time I was already aware how difficult and expensive it is to carry on patent litigation and I realized too well that we could neither afford the money nor the time connected with patent fights. So I preferred to take some chances and to keep the process secret long enough to permit us to build up a solid business by the time our competitors would have been able to devise the same methods.

Although I have had to change somewhat my views on the subject of patents, I still believe that the man who takes out a patent for chemical processes and does not have at his disposal abundant means to defend his patent-rights before the courts, is at a considerable disadvantage against unscrupulous infringers. Chemical process patents which can be followed out in secrecy can be too easily infringed with impunity because it is too difficult and expensive to establish these infringements before our courts of law.

"Product patents" for chemical substances protect somewhat better; but even there, litigation is considerably more difficult and intricate than for purely mechanical patents which are easier to understand by intelligent judges even if they have no scientific training; this important point of difference has too often been lost sight of in any proposed changes of our patent laws.

But whether you patent a chemical process or not, it appears to me of the highest importance to try it as soon as possible on a small commercial scale and thus test its essential practical details before risking too large a commercial enterprise on it.

#### ELECTROLYTIC SODA

I was fully imbued with these facts when, about twelve years ago, I was entrusted by my friend, Elon Huntington Hooker, with the examination of the Townsend cell. The inventor of this cell, Clinton Paul Townsend, one of the most clear-minded and careful men I have ever known, had already studied the details of his invention with a thoroughness which is rather uncommon; he furthermore, in its construction, had the benefit of the engineering experience of Elmer A. Sperry of gyroscope fame. Together they had practically tested out in the laboratory everything which seemed of importance about the design and operation of the cell. At that time there existed much skepticism as to whether a diaphragm cell for the manufacture of caustic soda and chlorine would ever rival the mercury cell, brought to such a remarkable state of perfection by that distin-

guished American inventor, Castner, a pupil of Professor Chandler.

Here, then, was a distinct advance in the art, an invention which for its commercial use required a plant costing millions of dollars. I felt it was dangerous to take any such large risk until there was an absolute certainty about the smooth working of the cell. I reasoned that we all knew *how good* the cell was under laboratory conditions where it was supervised by unusually able and skillful men, but it was just as necessary to establish *how bad* the cell would be if put under actual factory conditions where it would be operated by average labor. To investigate this was very expensive and took considerable time.

Two full-sized model cells were built and operated under varying conditions, day and night uninterruptedly for months. This gave us all an opportunity of improving details of construction. With the additional experience thus gained, we could now make more correct estimates and specifications for a full-sized plant. But even this plant was not built in full at once, but only to the extent of the smallest section which could be operated. We had thus further opportunities for detecting weak points and introducing further improvements or simplifications.

After this period, however, there was no further risk in the construction of the full-sized plant. Moreover, the experience which had been gained by the preliminary expenditure of about \$300,000, prevented blunders which might have cost several millions; through carefully planned development like this, the Hooker Electrochemical Company has to-day become one of the leading electrochemical concerns of the world.

In as far as my name has been connected with this enterprise, I take this opportunity of disclaiming any further credit for the success of its technical development, and more especially for the Townsend cell, beyond the fact that it was my good fortune to work in collaboration with a group of unusually able men. Aside from the men already mentioned, there were Albert E. Hooker, H. Willard Hooker, Clarence W. Marsh, Jasper M. Rowland, T. B. Lyster, C. N. Lansing, George W. Stone and others, all of whom did their full share in introducing a number of improvements.

I mention this example of successful team work in opposition to other instances where similar problems were entered into recklessly and where, either through impatience or through false economy, a large-sized plant was put up at an enormous cost before all doubtful details of the process had been eliminated with the result that the irregularities in manufacturing became so overwhelming and money losses became so heavy that the enterprise failed before it was possible to overcome them.

The principle "Commit your blunders on a small scale and make your profits on a large scale," should guide everybody who enters into a new chemical enterprise, even if it taxes the patience of some men who cannot conceive that one single apparently minor detail in a chemical process may upset all the good points and lead to ruin.

#### SYNTHETIC RESINS AND BAKELITE

When I undertook the intricate study of synthetic resins, which led to bakelite, I did not rest until I had mastered the details of the subject as far as my laboratory methods allowed me to do so. Then immediately afterwards I installed a small working unit where I could prepare the material in ton lots under various conditions, so that it could be tested right and left for practical purposes. Experience has taught me that many inventions may look very good to an inventor,



but some way or another do not suit the demands of the public. On this account, before embarking on a regular wholesale manufacture, I wanted to make absolutely sure that the new substance could be used permanently for the many different industrial purposes I had in view.

I reasoned as follows: "Here is a new material which might develop disagreeable surprises either in its process of manufacture or in its uses. Therefore, the best way is to manufacture it repeatedly on a small commercial scale for a limited number of users selected in such a way that I can watch easily the progress of their work."

As usual, I found that I had much to learn and had to change my views several times. At the beginning I had the erroneous idea that almost anybody would be able to make the new material easily, himself, and that it would simplify matters if I issued licenses on a royalty plan for the use of my patents without going myself to the trouble of any manufacturing work.

I soon found I was greatly mistaken in this, and that it would have caused no end of disappointment to teach to others chemical details which, to me, seemed rather simple, but which are easily overlooked by men who can not afford to concentrate their full attention on the subject. I concluded that a simpler way would be to sell them a partly finished product and to teach them how to use it.

But I noticed, before long, that I had to go again all through the same old experience as the introduction of *velox*. I found, to my astonishment, that people who were proficient in the manipulation of rubber, celluloid or other plastics were the least disposed to master the new methods which I tried to teach them or to appreciate their advantages. This was principally due to the fact that these methods and the properties of the new material were so different in their very essence from any of the older processes in which these people had become skilled. This rather unexpected drawback is so true that even to-day the most successful users of bakelite are just those who were not engaged in plastic before; this simply for the reason that they did not have to divorce themselves from the routine of older methods, and were willing to listen patiently to suggestions from newcomers in the field.

At the beginning I committed another mistake by trying to make the processes and the material as inexpensive as possible, using mostly the cheaper cresols, being guided by the idea that cheapness is a paramount consideration in the manufacture of plastics. It took me some time to find out that the best chances for bakelite lie where special technical effects are more important than mere cheapness, and that there is no use of wasting time and money in trying to introduce the new process in such cases where about the same results could be obtained by the older plastics. In other words, the process had to be introduced on its own merits, where, for instance, unusual strength or great resistance to heat or chemicals are essential, and not as a competitor to hard rubber, celluloid or natural resins.

The most important part of the problem we had before us was to give technical instruction to those who were willing to learn, and this technical instruction ranged from the first principles of how to use the product to all the engineering details of the equipment of their plant. It took me some time to realize that, contrary to my first intentions, it would create no end of disappointments and irregular results, and it would certainly kill the reputation of the process if every licensee were allowed to carry out, according to his own fancy, the different operations from the beginning to the end. I concluded that the best way for avoiding such a failure was to conduct the manufacture

of the raw materials to beyond the stage where chemical knowledge or too much experience is required.

At first I intended to sell the raw material unmixed with fillers, so as to let the individual user make his own molding compositions. This idea, too, had to be abandoned after I found that the proper preparation of these molding compositions in itself involved an amount of skill, knowledge and minutious care, which could hardly be expected from average workmen. Unless we followed this rule, we were exposed to clash all the time with conflicting opinions or attitudes as to what was advisable and what was not, not to mention the prejudices and petty notions of foremen or superintendents. Only after all these details had been well established and taken into consideration could I proceed to organize a complete factory, and similar establishments were started in Europe. Each of these factories was supplemented by a research laboratory and experimental department in which could be investigated the different applications of bakelite as well as the refinements in its processes of manufacture and a further general scientific study of the subject.

But even then we were soon confronted with the paradoxical situation that the greatest drawback of bakelite was its multiplicity of applications, which threatened the squandering of our efforts in too many directions at the same time. On this account, we had to adopt the policy of concentrating our attention along the lines of least resistance and to be guided somewhat by opportunities and learn when and where it was best to direct our efforts, leaving it to future opportunities for developing some of the applications which at first appeared rather attractive, but which were found to involve a disproportionate amount of attention or money for their successful introduction.

#### PROBLEMS CONNECTED WITH NEW CHEMICAL INVENTIONS

Most people do not realize that many new chemical enterprises present problems totally different from those connected with the running or the development of a purely mechanical industry. Indeed, some chemical processes involve factors and details which are not always easy to ascertain beforehand.

To embark upon such enterprises without testing out beforehand these factors is very much like plunging into a gambling proposition; therefore, it is better to spend the necessary money on preliminary research work and preparation, then start tentatively on a modest scale, even if it tries your patience and your pocket-book. Then after you have every right to feel sure about your proposition, there is no longer any reason for further hesitation in extending your plant to the required size.

#### THE IMPORTANCE OF SELECTING THE RIGHT BUSINESS ASSOCIATES

In my latter enterprise I was able not only to carry out all my preliminary work by my private resources, but I felt that, if necessary, I could run the whole commercial enterprise without the financial assistance of others. This undoubtedly put me at a great advantage, as I was not hampered by any interference with my plans. If I had looked at the narrow money side of the proposition, I might have concluded that in as far as I was practically sure of the ultimate success of this enterprise, there was no reason to divide profits by accepting financial support from others. But I had learned by former experience how very valuable it is to have the coöperation of competent men for advice or influence. Therefore, in selecting business associates for my new industry I took less in consideration any money they were willing to introduce as stockholders, than

their exceptional personal qualifications and business experience.

This point of view, on which I put great stress, is too often overlooked by chemists who start in a new enterprise where they are primarily confronted with the problem of finding the necessary funds. Frequently they make reckless connections with almost anybody who can furnish them the first money, regardless of whether they are the proper persons to help or advise or inspire them in their work, or whether they are men utterly uncongenial or who do not see in an enterprise anything but getting quickly as much cash as possible out of it, quite regardless of any other consideration.

If in the enterprises with which I have been connected I managed to get along pretty well, I can attribute it, to a large extent, to the fact that in each instance I had the good fortune of being surrounded with congenial partners or collaborators who, instead of causing friction and irritation, aroused my highest enthusiasm.

Nor do I think the grouping of business associates simply a matter of luck. It is worth some deliberation in picking out the right men. If in some instances I made a mistake, I did not hesitate to rectify it even at considerable trouble and pecuniary sacrifice. To put my opinion in a short formula, I would say: "Better do not attempt much if you have as business associates only men whom you cannot trust, or who do not trust you, or who irritate or depress you, or who are dangerous by their greed, their recklessness, their superficiality, their weak character, or their general unreliability."

#### CONCENTRATION OF EFFORTS

Whatever task I undertook I found it necessary to concentrate my full attention and my full enthusiasm on it, sometimes during several years in succession, until I felt I had overcome all the main difficulties connected with that line of work. During these periods of intense concentration I hardly had the time or the desire to take interest in anything else; so much did I become enwrapped in my subject that even a vacation was irksome to me, because it took me away from my favorite problem.

It was only in these periods of interval between each succeeding enterprise that I made up abundantly for all this and relaxed and was open to any other matters which might strike my fancy. Then during such intervals I lost almost entirely my interest in problems which I had successfully solved, but was ready to take up a new thing.

This explains perhaps why the different subjects with which I have been connected are so little connected among themselves, and are situated in almost opposite corners of chemistry. The very difference of the succeeding subjects contained in itself that element of novelty which fed my interest and enthusiasm. It was every time like turning a new leaf, and this prevented me from becoming too one-sided.

I should state, however, that the older I became the more cautious I was not to spend my enthusiasm on subjects which I considered unworthy of my best efforts. Several of my friends asked me, "How did you happen to strike such an interesting subject as that of the synthetic resins? I can readily answer that I did not strike it haphazardly; I looked for just such a subject for a number of years until I found it among the many lines of research which I undertook in my laboratory. More than once it has happened that at the end of years of work on some particular subject or another I had to come to the conclusion that what I had found was not worth while following up further, although it

might appear attractive enough to other chemists. So, more than once, I abruptly closed my work on some subject or another and took up another line, until finally I succeeded in finding a subject on which I could feel thoroughly enthusiastic. In this way my work became a real pleasure, regardless of whether at the end it was going to bring the results which I had expected or not.

There is no doubt that I had a decided advantage over most of my fellow chemists who cannot dispose of their time the way they please, but who are bound to certain subjects whether they like them or not. If I had remained bound to my first successful enterprise, or if I had tied myself to others in some way or another, in the desire of making money, or for other reasons, I would not have possessed, at the age of thirty-five years, that absolute freedom of my time which gave me such excellent opportunities for further study and work along more congenial lines.

#### DANGER OF STARTING CHEMICAL ENTERPRISES WITH INSUFFICIENT CAPITAL

A great mistake has frequently been made by chemists of starting into a new business with just enough money to get along, provided everything went well. Starting a chemical manufacturing enterprise with insufficient capital is one of the surest ways of getting caught in failure. I can say that I know of few chemical enterprises, if any, where the initial expenses were not decidedly higher than what was estimated at first.

This is usually the most critical period through which every enterprise has to pass. It happens too often that there is not enough reserve capital at hand for weathering safely through the first storms through which the newly launched ship has to navigate. It is easy enough to find all the capital when things go smoothly, but it is hard work to decide anybody to advance funds for a business enterprise which encounters troubles, except at an entirely disproportionate sacrifice. More failures in chemical enterprises have resulted from this than from almost all other causes.

#### PRESENT OPPORTUNITIES FOR CHEMICAL INDUSTRY IN UNITED STATES. POSSIBLE SOURCES OF FAILURE

If I have risked trying your patience by going into all these details of a rather personal nature, or by giving my opinion as to the causes of success or failure of chemical enterprises, I beg to assure you that in doing so my object lies higher than merely to pose as some kind of an example to any of you.

I want the men of this country who are desirous of joining in your chemical enterprises to realize that it is not enough to have good chemists at their disposal. I want to try to convince them that there are numerous conditions under which even the best chemists cannot possibly make a success. I would like to impress this fact upon all those who have the welfare of our nation at heart at a time when no country in the world has ever had such extraordinary opportunities for becoming foremost in all branches of chemical industry.

I ask myself: Will our present magnificent opportunities lead us to efficient development of an unprecedented advantageous position, or shall we stumble and fall through sheer blundering in the way we conduct our new chemical enterprises; will these unparalleled chances of success only result in some kind of a "flash-in-the-pan"? If we turn our present opportunities into a gigantic fiasco, then let me tell beforehand to the public at large that we should not put the whole blame on our chemists.



This country has enough able chemists, all eager to do their full share of good work. Our principal universities and engineering schools are now at least as good, for all practical purposes, as the very best European institutions of the kind. If some special branches of chemical industry as, for instance, synthetic dye manufacturing, have not attained here, in the past, the same development as in Germany, this was mostly a matter of different opportunities. On the other hand, we can point to some of our other chemical industries, where conditions were more favorable and where this country has become a leader in quantity, in quality, and in pioneership.

Shall we now strengthen our position of economic independence from foreign countries by adding new chemical industries for which heretofore there was scant inducement for the man of enterprise, alongside of much better opportunities in other directions? Shall we become what we ought to be with the abundant opportunities just now at our disposal—the greatest center of chemical enterprise of the world?

The answer to this question will depend at least as much on the kind of men who are at the business end of these new chemical enterprises as on the chemical part of the problem. In this respect I look with considerable apprehension on the future of some of the ventures which are being started now by men who are merely trying to make quick money and who, in a chemical enterprise, see only a pretext for realizing their greedy ambitions; men who look upon their chemists merely as temporary tools, ready to sacrifice their enterprise and everything connected with it as soon as they can quickly cash in their profits, instead of trying to build up a permanent establishment run along steady business lines with a good underlying financial foundation, with the purpose of insuring, for years to come, regular and lasting profits, even if they may seem more modest.

It will certainly do no harm to many of our new chemical enterprises if among their directors they have at least some chemists as well as purely business men, or bankers and lawyers. I know that such a statement will go against the belief of some of my friends who imagine that a chemist or a technical man is essentially unfit to treat a business proposition in a business-like way. If the average chemist makes a poor business man it is simply due to the fact that he seldom, if ever, has an opportunity of obtaining business experience by being allowed to participate in discussing important business propositions in the councils of the concern that employs him. I would like to ask some of our business men how they ever would have acquired business sense and business methods if they never had been allowed to learn to exercise their judgment in the handling of business problems?

It is really a sad thing to see in this and some other countries so many chemical companies where the board of directors does not comprise any chemists, except in a subordinate capacity. Why should a chemist, if he is intelligent enough to master the most intricate problems of chemistry, not be able also to learn how to exercise enough common sense and good judgment to help to discuss and devise successful business policies?

Those of the large chemical enterprises of the world, which are counted as a model in their line, have always had prominent chemists among their directors, and the policy of these enterprises has not been left entirely in the hands of a set of purely business men who remained willfully ignorant of the essential technical facts upon which their enterprise was based. I have known too many instances where serious technical difficulties were not estimated at their proper value

by ignorant directors and where serious losses, disappointments and even failure arose from that source.

Of course, it would be out of the question to expect that every director in a chemical enterprise should be a full-fledged chemist, but he ought at least, to some extent, be able to follow the difficulties, the vicissitudes and progress of the technical problems with which the enterprise is confronted. It has been my experience that intelligent business men, even if they have no technical or scientific training, can easily be made to follow with intense interest the technical questions of a chemical enterprise, provided there be among them, as fellow-directors, some chemists who can keep them informed, without going into unnecessary details, and who in doing so can speak with some authority, instead of the directors obtaining their information from subaltern employees who are often so dependent on their position that they are too timid to speak without hesitation, or to impress their views with some insistence.

#### OUR BANKS ILL-PREPARED FOR NEW CHEMICAL ENTERPRISES

The matter of financial support for new chemical enterprises is another subject which might be considerably improved in this country. The most successful chemical enterprises of the world have been started in a small way. At first sight this would seem an unequivocal advantage; in reality it is often a serious disadvantage from the banking standpoint. Our big banks are willing enough to back vast enterprises, but look with contempt at beginning industries. Nor have our banks the organization to enable them to investigate promptly or inexpensively the prospective merits of such small scientific enterprises.

The result is that when a chemist has a good idea he has to look for private financial backers. If he could do this directly this might be well enough, but most of the time he has to go through the intermediary of a promoter, who complicates matters considerably by interposing himself as a self-constituted middle-man, and who usually begins by diluting in advance the prospective profits of the concern, even if he does not attempt foremost to insure his own immediate benefits to the detriment of the healthy future development of the enterprise.

Before the convulsions which are now shaking Europe your ardent sympathies may lie with one or the other side of the fighting nations. But your personal likes or dislikes do not diminish the fact that Germany has set us an example in industrial preparedness and that her large banks, long ago, have mastered the art of nursing new chemical industries. Those large German banks have their staff of scientific experts, whom they freely consult about any new chemical enterprise which requests their financial support. To these scientific representatives of the bank, the chemist or inventor can talk in his own scientific language and explain clearly what he has to propose, without being barred in his appeals by the hopeless ignorance in technical or scientific matters of the bank directors, or without having to resort to the trick of playing on their imagination or hypnotize them with fairy stories and stun them with exaggerated promises.

Just imagine what it would mean here in this country for a chemist to know that he can be backed by respectable banks, in any legitimate enterprise, however small, provided he can explain to their experts, in his own way, that he has reasonable probability of success. The prestige of the bank alone would give him confidence in his work, and make him immune against the usual tactics of crushing and violent com-

petition to which his powerfully established competitors might try to subject him.

Our large American banks know how to float railroad projects, loans, real estate transactions, or to consolidate established enterprises, or issue bonds or carry out similar wholesale financial operations; but they have not yet begun to learn how to support beginning enterprises based on new scientific discoveries and which on this account can best thrive and grow to powerful maturity if allowed to be tentatively started on a small scale, provided they can reckon on adequate financial support when they need it.

#### THE HIGHER EDUCATIONAL EFFECT OF CHEMICAL ENTERPRISES

I would certainly not take such an intense interest in the future development of the chemical industries of this country if I looked into this matter merely from the standpoint of a so-called "prosperity" of dollars and cents. I know too well that there are easier means of making money. But I am convinced that a nation of which the prosperity is based on the development of scientific industries is bound to furnish citizens of more worthy aims than a community where people get rich by slaughtering hogs and cattle, or by speculation in the fluctuating prices of real estate, or stocks and bonds, or merchandise, or by any other occupation where gain is the exclusive purpose.

A successful industry built upon sound scientific knowledge does not mean merely dividends for its stockholders or wages for its workmen. It consists in putting in practice principles of efficiency and introducing knowledge where formerly existed ignorance, and its usual accompaniments of waste, slovenliness, misery, want, vice and sorrow. It means surrounding our life with increasing and better opportunities by using the laws of nature to the greater help of man.

Progress, in general, is very slow to grow and is still more slow to assimilate. But strange to say, our reactionary attitude has, in some cases, been cured through sheer greed. To state it brutally, science only began to make rapid progress as soon as it found applications which led to the payment of cash dividends.

Chemical and electrical companies, for instance, spend more money for research and scientific investigation than all the universities combined. The result has been that it is just those two fields of science which have shown by far the greatest development, as compared to all others. By a sort of hyperinduction, science, after helping industry, got stimulated itself by the growing exigencies of industrial enterprises.

But some of you will ask me: "Where does all this lead to; will the world at large be better for it? Are not our scientists, our chemists and engineers just those who have helped to make the present war so atrocious?" To this I can answer without hesitation, that those who are responsible for what is happening now are not the scientists themselves, even if their work has been impressed into service for means of destruction and sorrow. War is many ages older than science! Greed, iniquity, lust for power, the main inheritance of the aims and thoughts of the past, rendered respectable by a rather large share of our so-called classical literature, together with our awe for tradition, are the main influences which keep us in the cold, relentless grip of the wrong ethics of bygone ages.

Even our men of science have not been able to shake off entirely so many superstitious beliefs, so many erroneous traditions, rendered respectable through pedagogic smugness and—shall I say it—with which

the minds of the children of each succeeding generation have been mummified in prejudice of certain points of view. This accounts for the fact that the average man is still more easily swayed by elegant phrases than by scientific truths. True science, on the contrary, has no more respect for the most brilliant rhetoric of classical literature, if this latter promulgates ideals which are contrary to facts, than it has any patience with the utterances of a politician whose passion or interest makes him overlook or distort facts.

As far as the ethical side is concerned, has it ever occurred to you that, notwithstanding the fact that chemistry and electricity have enriched an enormous number of people, there are few, if any, instances where scientific men, engaged in applied science, have become as absurdly rich as some of the big money hoarders of this world? Why? Because their work is too interesting to induce them to get into a life of mere money-getting; for the chemist the financial consideration is a necessity for his existence, but that is not the chief end, as it is for those whose conception of success does not go much beyond the desire of money or power.

To him whose imagination is so rudimentary that he can perceive nothing else in the cultivation of science than dry knowledge, shrivelling up of all sentiment, I should say with Jacques Loeb (see *Yale Review*, July, 1915, "Mechanistic Science and Metaphysical Romance") that there is a sufficiently wide play for our emotions in our generous response to all that is beautiful and just and in our sympathy with all those who suffer or are treated unjustly, and that the active participation in the improvement of the masses, economically, physically, socially, intellectually and esthetically, will offer for a long time to come a sufficient outlet for all human desire for emotion. What progress the world has made, not only in physical welfare but also in the conquest of superstition and hatred, and in the formation of a correct view of life it owes directly or indirectly to exact science.

It is infinitely more costly if a mistake is made in arousing nations or social groups to hatred or fear than if a mistake is made in some special problem of physics or biology; but by an irony of fate the denunciation by society in the latter case is apt to be much more severe than in the former. This is the result of the fact that the rigid consideration of truth and the feeling of responsibility for truthfulness which exact science has established, have not yet reached the masses. And this situation will last until the influence of the metaphysical romanticist has been replaced by that of the scientist.

To you, then, and all those who are willing to build up chemical industries, let these thoughts be the guiding inspiration of your work.

My friends, chemists of America, how can I let pass an occasion like this without reminding you of what you did for me?

Twenty-seven years ago I came here as a stranger among you and now I feel so much as one of you that sometimes I wonder that there was ever a time when we did not work and play together.

When I was young and poor and unknown you never hesitated to extend to me the cordial hand of welcome, you never missed an opportunity to show me your friendliness, to help me by advice or otherwise. Much of what I have used in my work I learned from you at the meetings of our chemical societies, or in the brotherly surroundings of our Chemists' Club.

You—your friendship, your generosity, your good-natured modesty, your example, inspired me in my work.

I wish I could better express my thanks.



## Baltimore Meeting of the American Institute of Chemical Engineers

An account of the proceedings of the first day (Wednesday, Jan. 12) of the Baltimore meeting of the American Institute of Chemical Engineers was given in our issue of Jan. 15, page 70. The papers by Mr. H. W. Jordan, on the development of the chemical coal-products industry in this country, and by Dr. Arthur D. Little, on wood-waste utilization, which were both presented on this day, are printed in full on pages 144 and 133 of the present issue respectively.

### The Barium Industry

Of the last paper of the Wednesday evening session, presented by Mr. MAXIMILIAN TOCH on "the barium industry," we herewith give a fuller account, as it also dealt in a very interesting way with broader economical problems.

A metamorphosis has come over the United States within the past eighteen months such as no one could possibly have foretold, for the manufacturing industries allied to applied chemistry have been so thoroughly upset and have undergone such tremendous changes that conditions have arisen which are unparalleled.

Ever since any one of us can remember, it has been an axiom that sulphuric acid could not be profitably shipped beyond a radius of three hundred miles. Now sulphuric acid is shipped at a cost of freight alone amounting to twice its value of two years ago, and if the condition of affairs which exists now is going to continue for another year sulphuric acid may rise to a value of from  $\frac{3}{4}$  cents per pound to 8 or 9 cents per pound. I say  $\frac{3}{4}$  cents a pound, knowing that contracts have been entered into in this very city of Baltimore three years ago at \$5.25 per ton, or a little over  $\frac{1}{2}$  cent per pound. The great advance in the price of sulphuric acid alone is not the most unfortunate thing—the real misfortune is the fact that those of us who need it and depend upon it cannot get all we need at any price, for there isn't enough sulphuric acid made in the United States to meet the abnormal demand.

Two years ago the barium industry in the United States was unknown. True, several thousand tons of barite were imported from Germany and used on the coast of the United States for making lithopone. American barite was not used for manufacturing barium salts for the reason that the freight from Tennessee and Missouri to the Eastern coast of the United States was equal to the total cost of the barite delivered on the coast from Germany and in many instances duty paid. The prevailing price for imported barite prior to 1914 was \$5.75 per gross ton landed at tide-water duty paid. The freight from Tennessee and Missouri was between \$4 and \$5 per ton; but suddenly out of a perfectly clear sky the nations of Europe grappled each other in a death-dealing struggle, and the United States was isolated from the chemical industries of the rest of the world, and those of us who had manufactured barium salts out of foreign raw material were compelled to cast about for the American minerals or else go out of business entirely.

Mr. Toch then sketched how his firm had entered the barium industry by erecting a plant at Sweetwater, Tenn. (see page 47 of our issue of Jan. 1), and offered a strong argument for a protective tariff.

Every pioneer country—and the United States is certainly a pioneer country—demands that its laborers be paid a higher wage than is necessary in the old world's settled districts. I do not speak idly, because I have studied labor conditions in the chemical industry in many of the European States. I recall particularly the conditions as they existed in Italy before the war. The same laborer who in our factory gets \$1.75 per day, and we have a number of Italian laborers who do much of the menial work—I do not mean our factory in Tennessee, but in Long Island City, N. Y.—are the same men who get 2 lire, or 40 cents, per day in Italy. The existing conditions in the district around Rome, for instance, twenty years ago were that laborers obtained 1 lire per day and board, and the board was calculated to be not over 1 lire per day, for meat and other high priced articles of food are practically unknown there. Conditions have changed in the last twenty years until now the laborer there gets 1.50 lire and board, or 2.50 lire without board. In Germany it is just about twice this amount, and in the manufacturing districts of England about 25

per cent more than in Germany, although I am frank to say that since the war I have no knowledge of the exact wages paid, but I understand on very good information that the wages have risen very materially owing to the shortage of labor.

There is absolutely no way for compensating for these economic differences in America, excepting by means of a tariff. The question of an "anti-dumping" law might possibly work out, but it is an untried factor, and although it may have good results there is no way of telling whether it would be beneficial.

Subsidy might be another way of helping the American manufacturer, although subsidy is against the policy of the United States, and it is quite obvious that if one industry were subsidized by the United States Government by direct money grants, there probably would be a newspaper revolution, to say the least. Japan, that wonderful little country which is destined to be a wonderfully big country in time, has already both subsidized and protected her chemical industries to such an extent that eventually Japan is very likely to become an exporter of chemicals and dyes where ten years ago it practically made none.

Barite is mined in the form of natural sulphate of barium. The analysis is important. "I would rather have a barite which contains 10 per cent of harmless impurities like clay and iron than a 98 per cent barium sulphate that contains 1 per cent of fluorine and lime, for while the yield in the former composition would not be so great, the yield with an improper kind of barite would not count at all, because the lining of the furnace might be practically destroyed through the presence of noxious elements."

There are at present only four barium manufactories in the United States at the present time—one of them is manufacturing the hydrate and the peroxide in relatively large quantities. My firm has devoted its entire work to the manufacture of practically the crystalline salts, like the nitrate, chloride, some sulphate and a great deal of carbonate, and in the process which we use, sodium sulphide is a by-product, which now commands the same price as the barium salts themselves. Of course, the bottom is going to drop out of all of this if we don't get the right protection, and it will indeed be a pity if the industry will suffer.

The manufacture of the barium compounds is by no means as easy as the elementary text books indicate. One of the most difficult things that I know of—simple though it may appear on the face of it—is the manufacture of precipitated barium sulphate. The barium salts are all regarded as highly poisonous, and the probability is that they are excepting those that are insoluble, like barium sulphate; and yet pulp barium sulphate is a wonderful nutrient for micro-organisms, and I have seen most beautiful and white barium sulphate decompose and become putrid in two months, and the average fungicides or bactericides known to science have had little or no effect on them. So the chemical engineer who has had a training in bacteriology and microscopy has an advantage over the lesser trained man.

Chemists have probably regarded that there is only one barium sulphate. I now know of three various types totally different under the microscope and heterogeneous in their applications. We have long been familiar with the fact that the same chemical compounds produce very different acid salts and have totally different physical qualities, and as an example I can tell you simply that lead chromate made from potassium bichromate and lead acetate, is different in its appearance from lead chromate made from potassium bichromate and lead nitrate. The resulting chemicals are identical, but in physical aspect and in color aspect they are different. The same applies to the barium salts made of different chemicals. From time immemorial the precipitated barium sulphate of commerce has been made from barium chloride and glass makers' salt cake or neutral sodium sulphate. Since the war barium chloride has become prohibitive, and there is not enough salt cake to go around, consequently the barium sulphate made in other ways is totally different from that which we have formerly known.

And so this new industry has given us new problems, costs and methods of manufacture. The scale upon which the materials are made, together with the protection which should be afforded to us by a paternal government, will in the end decide whether this industry shall live.

### Business Sessions

There were two business sessions held, one on Wednesday morning, the second on Friday morning. During

the Friday session Vice-President Dr. G. W. Thompson was in the chair.

At the Friday session the result of the election of officers was announced. Dr. GEORGE D. ROSENGARTEN was re-elected president for another year, and Messrs. G. W. Thompson of Brooklyn, N. Y., A. C. Langmuir of Brooklyn, N. Y., and John M. Stillman of Stanford University, California, continue to serve as vice-presidents.

The committee on public policy offered a report in which the readiness of the American Institute of Chemical Engineers to serve the Government when its services are needed was emphasized, either in a general way or in specific matters. The report was referred to the council with power to act.

The next meeting will be held at Cleveland, Ohio, probably in the latter half of June.

One of the later meetings will be held in St. Louis, and for the St. Louis members Dr. Frerichs tendered a very cordial invitation to the Institute, and spoke eloquently of the various industrial plants which could be visited in or near St. Louis.

A technical session followed.

#### New Process of Bleaching

A paper by Dr. S. F. PECKHAM on "a new process of bleaching" was read in the absence of the author by the secretary, Dr. Olsen.

Some years ago someone put before Dr. Peckham the problem of bleaching flax fiber by a quick process without injury to the fiber. Some thirty years ago Charles Toppan had patented a bleaching compound of which the fixed oil of mustard and petroleum were the essential ingredients. A study of this process from all available sources led Dr. Peckham to conclude that Toppan's compound, which was originally a lubricating compound, consisted of a fixed mustard oil soap dissolved in petroleum, and that by varying the proportion his bleaching compound consisted of petroleum or its distillates dissolved in a solution of fixed mustard oil soap.

In investigating this matter further Dr. Peckham found that the different benzoles dissolve in soap solution much more readily than the petroleum distillates and that the cleansing effect on the flax fiber is marvelous. Immersion in very dilute bleaching solution produced a perfect dead white bleach and left the fiber unimpaired in strength.

This method can be successfully applied to all vegetable fiber as linen is the most difficult to bleach of all of them without injury to the fiber.

I have never seen any mention made in chemical literature that benzole and its derivatives are soluble in a solution of soap, nor did I ever hear any statement to that effect. No fixed formula can be designated as soap is soluble in water in all proportions and the stronger the solution of soap the more benzole the solution will dissolve. The formula I used was for 100 lb. of flax.

Water .....	50 gal.
Soap .....	10 lb.
Benzole .....	3 gal.

This was used for a heavy woven linen damask, while for ordinary light cotton, such as "gray cloth," very much less material is necessary. It need not be pure benzole, but any of the light distillates of coal tar, coke oven tar or blast furnace tar, freed from impurities by washing and proper treatment.

My invention consists of a process of bleaching by substituting for the usual lime and soda boils a single boil in a solution of soap, preferably a pure vegetable oil soap, in which is dissolved a sufficient quantity of benzole ( $C_6H_6$ ) or its homologues or derivatives as found in the light distillates of coal tar and similar liquids and in light distillates of some varieties of petroleum, especially that of California as distinguished from the light distillates of paraffine petroleum. The strength of the solution in both soap and benzole would depend upon the kind and character of the ma-

terial to be bleached, light cotton fabrics requiring less than heavier cottons, and any cotton less than flax, jute or hemp.

After thorough squeezing and washing to remove the soap solution, the goods or fiber may be bleached in any known chemic, but I prefer a chemic of my own invention consisting of a solution of sodium hypochlorite, prepared by pouring together, cold, a solution of 58 per cent soda ash and a solution of calcium hypochloride, stirring the mixture and allowing it to settle. Both solutions should be prepared cold, and after mixing the solutions they should be allowed to stand at least four days or until all the available chlorine in the calcium hypochlorite shall be found in combination with the sodium and in solution. No formula can be assigned for this mixture as calcium hypochlorite varies indefinitely in strength. The quantities taken should be such that there should be a slight excess of the sodium carbonate. After a great many experiments upon this chemic I have found this method of preparation, which is very unlike any which is laid down in the books, to be the only one that will bring all the available chlorine in the calcium hypochlorite into solution as sodium hypochlorite. It is better to prepare this solution of a strength 3° to 5° Twaddle, and dilute it to such a strength that an immersion of the goods from 3 to 5 hr. will effect a bleach. After washing the bleached goods in water, they are soured, washed and calendered as usual.

By this method a complete bleach of either cotton or linen can be had in from one to two working days.

I have described a process of bleaching by which the goods or fiber are prepared for the chemic by boiling in a solution of soap in which has been dissolved a sufficient quantity of benzole or its homologues or its methylated derivatives, either separately or mixed together, as found in coal tar naphthas and similar liquids and the distillations from some petroleum as above set forth.

The soap which I have used is the cheapest that I know of on the market, as it is a by-product of the refining of cotton seed oil and is used in its crude state without further treatment.

The apparatus used is a kier with a steam jacket to which is attached an inverted condenser which returns the evaporated hydrocarbons to the kier. The process was applied on a small scale and thoroughly tested out with the most gratifying results. Of course, the goods are singed and sheared as is customary. Goods in small pieces were digested for various periods of time and the resulting goods subjected to a great variety of tests excepting the effects of time upon finished goods. It was found that if the goods were thoroughly dried after thorough washing to free them from soap the effect of the chemic was very much more satisfactory than when they were introduced into the chemic damp, directly from the squeezers. This is not surprising when very dilute solutions of chemic are used as the water remaining in the goods from the squeezers not only diluted the chemic still further but filled the pores of the goods, thus getting in the way of the chemic and preventing it from doing its work.

#### Lutes and Cements, and Water Purification by Ozone

A paper by Mr. S. S. SADTLER of Philadelphia on "lutes and cements for chemical purposes" was next presented. In the absence of the author it was read by the secretary, Dr. Olsen. This interesting and useful paper will be published in full in our issue of Feb. 15.

The last paper of this session was presented by Mr. POWELL, on the system of water purification by ozone employed by the Baltimore County Water Company. The system was developed by their chief engineer, Mr. Walton, and its most interesting feature is the use of aluminium electrodes and micanite tubes for the dielectric. The over-all cost of purification is below \$2 per 1000 cu. ft. of water.

#### Friday Evening Session and Excursions

For the evening of Friday a joint meeting with the Maryland Section of the American Chemical Society had been arranged, the program comprising a paper by Dr. G. W. THOMPSON on changes in the volume and specific gravity of linseed oil films on drying and a paper by Dr. H. E. IVES on artificial daylight. This was followed by a smoker at the Johns Hopkins Club, given by the Maryland Section of the American Chemical Society.



A very fine program of excursions had been arranged. On Wednesday afternoon two different parties were formed; one visited the Maryland Steel Company's plant at Sparrow's Point, the other the Baltimore sewage disposal plant and the ozone water purification plant.

On Thursday an all-day excursion was made to Annapolis.

On the evening of Thursday a subscription dinner was held at the Emerson Hotel. It was well attended and very enjoyable. Dr. Charles F. McKenna was a brilliant toastmaster.

On Friday afternoon three excursions were made. One party visited the Standard Fertilizer Works and the Davison Chemical Works, the latter being one of the largest sulphuric acid plants and containing much of considerable interest. Another party visited the Maryland Glass Corporation, and a third party the new buildings of Johns Hopkins University.

The chief excursion on the program for Saturday was to the Tidewater Portland Cement Company at Union Bridge, Md.

### Synopsis of 1915 Mineral Production

From advance estimates of the production of ores and metals in the United States, made by the U. S. Geological Survey, we abstract the following essential data:

In the Western states alone the metal production shows an increase in value of more than \$130,000,000 over the corresponding figures for 1914; and the year's increase in output for the principal metals measured in value is more than \$250,000,000. Moreover it is not unreasonable to expect that when the full returns for all mineral products are compiled they will show that 1915 was the country's most productive year in the mining industry. The total may even reach two and one-half billion dollars.

The copper mines passed all records for previous years, the 1915 output having a value of \$236,000,000, or \$83,000,000 more than the value of the production for 1914. The statistics and estimates received place the output of blister and Lake copper at 1,365,500,000 lb. or more than 120,000,000 lb. in excess of the largest previous production and 18 per cent above last year's figures. Only twice in the history of copper mining has there been a larger increase in quantity of metal produced.

The total shipments of iron ore from the mines in the United States in 1915 are estimated to have exceeded 55,000,000 gross tons, an increase over 1914 of more than 38 per cent. Based on the same price as received in 1914 this represents an increase in total value of about \$27,645,000. The increase in pig iron is estimated at 6,500,000 tons, with a total increase in value of pig iron production of more than \$120,000,000.

The output of zinc (spelter) made from domestic ores was larger than ever before, being about 425,000 tons, worth \$120,000,000, as compared with 343,418 tons in 1914, an increase of about 82,000 tons, or nearly 25 per cent in quantity and of \$85,000,000 in value. Production was increased during the latter half of the year, as the production during the first half was at the rate of 415,000 tons annually and at the rate of 436,000 tons during the last half.

The output of refined pig lead from domestic ores was about 515,000 tons, worth about \$48,500,000, as compared with 512,794 tons in 1914, an increase of only 2500 tons in quantity but of \$8,500,000, or 20 per cent in value. The production of antimonial lead was 20,550 tons, as compared with 16,668 tons in 1914, an increase of 3882 tons or 23 per cent in quantity and an increase in value of nearly \$2,000,000.

The annual preliminary estimates on the production

of gold and silver in the United States, made jointly by the United States Geological Survey and the Bureau of the Mint, are not yet complete, but early figures based on reports from the mines indicate an increase in mine production over that of 1914 of over \$7,000,000 in gold, principally from Colorado, California, Alaska, Montana and Idaho, and an increase in mine production of silver of fully 4,000,000 ounces, chiefly from Montana, Utah and Arizona. This increase in gold production may bring 1915 up to the record year of 1909, when the gold output of this country was nearly \$100,000,000.

Quicksilver also has had its best year in 1915. The quantity increased 25 per cent over 1914, but the value of the output more than doubled owing to the much higher prices. The estimated production was 20,681, flasks of 75 lb. each, valued at the average price for the year—the highest in the last forty years—at \$1,768,225. In value, this domestic production was the highest since 1881 and in quantity the largest since 1912.

#### Arizona

The output of gold, silver, copper, lead and zinc at mines in Arizona in 1915 was valued at \$88,551,000, according to the United States Geological Survey, an increase of nearly 48 per cent over that of 1914, which was \$59,956,029. There was very little change in the output of gold, but there were notable increases in the other metals, especially in lead and zinc. Increased prices made a difference of nearly \$26,000,000 in copper, \$400,000 in lead, and over \$2,000,000 in zinc. The output of gold in Arizona mines increased about 1 per cent over that of 1914, which was \$4,179,155. A record production of silver was made, the output increasing from 4,377,994 oz. in 1914 to about 5,458,000 oz. in 1915, or over 24 per cent. The value of this output increased about \$2,718,000. Arizona is the leading copper-producing State of the country and had an output of nearly 450,000,000 lb. in 1915, an increase in quantity of nearly 57,000,000 lb. and in value of nearly \$26,000,000. The mine output of lead increased from 15,003,068 lb. in 1914 to about 22,272,000 lb. in 1915, an increase of over 48 per cent. The value increased from \$585,120 to \$1,033,000. The mine production of zinc, estimated as recoverable spelter, increased from 9,792,337 lb. in 1914 to about 17,729,000 lb. in 1915, an increase of 81 per cent. The unusual average price of zinc for 1915 gives a value of about \$2,524,000 to this product.

#### California

California mine figures for 1914 were \$20,653,496 in gold and 1,471,859 fine ounces of silver; the estimates for 1915 indicate an output of \$22,860,590 in gold and 1,974,529 oz. of silver, an increase of \$2,207,094 in gold and 502,670 fine ounces of silver. California remains the premier gold-producing State of the country. The yield for 1915 is the largest in thirty-two years and with one exception the largest in fifty-one years.

The silver output from the mines shows an estimated increase in 1915, as compared with 1914, of 502,670 oz. The estimated mine yield of copper in 1915 is 44,098,552 lb., as compared with 30,507,692 lb. in 1914, an increase for 1915 of 13,590,860 lb. The mine output of lead in 1914 was 4,251,923 lb.; in 1915 it is estimated at 6,346,319 lb., an increase for the latter year of 2,094,396 lb. The estimated zinc output of the State in 1915 is 11,443,926 lb., against 389,471 lb. in 1914, an increase for 1915 of 11,054,455 lb. This is the largest production of this metal ever made in California in one year.

#### Colorado

The mine output of Colorado metals for eleven months of 1915, with an estimate for December, indi-

cates a yield for the year of \$22,330,000 in gold, 7,080,000 oz. of silver, 66,664,000 lb. of lead (in terms of lead bullion and lead in leaded-zinc oxide), 7,100,000 lb. of copper, and 100,000,000 lb. of zinc (in terms of spelter and zinc in zinc oxide), with a total value of \$43,100,000, compared with \$19,883,105 in gold, 8,796,065 oz. of silver, 74,211,898 lb. of lead, 6,639,173 lb. of copper and 96,774,960 lb. of zinc, with a total value of \$33,460,126 in 1914. This shows an increase of \$2,447,000 in gold, decreases of 1,716,000 oz. of silver, and 7,550,000 lb. of lead, an increase of 306,000 lb. of copper and 3,200,000 lb. of zinc. With the increased average value of metals, except silver, the values show a decrease of \$1,380,000 for silver, an increase of \$300,000 for lead, an increase of \$340,000 for copper, and an increase of \$8,065,000 for zinc.

#### Idaho

The output of gold, silver, copper, lead and zinc from ores sold or treated from Idaho mines in 1915 had a total value of about \$37,780,000. This is an increase of more than 53 per cent over the production of 1914, which was valued at \$24,645,848. There was no great change in the output of gold and a slight increase in that of silver, but there were material increases in the production of copper, lead, and zinc, especially of zinc. The increase in the total value of these metals, amounting to over \$13,000,000, was due largely to the increased price of lead and zinc. The mine production of gold was nearly the same as that of 1914, valued at \$1,152,315. The production of silver increased from 12,479,516 oz. in 1914 to about 13,000,000 oz. in 1915, or more than 4 per cent. The price of silver, however, was comparatively low and the value of the output was over \$400,000 less than in 1914. The output of copper was increased from 6,445,187 lb. in 1914 to about 7,169,000 lb. in 1915. The mine output of lead, which is the main mineral product in Idaho, increased from 348,526,069 lb. in 1914 to about 377,000,000 lb. in 1915. Shipments of zinc ore and concentrate increased from 54,754 tons in 1914 to about 97,000 tons in 1915. The shipments contained about 80,000,000 lb. of recoverable spelter, valued at over \$11,000,000. On account of the unusual price for zinc in 1914, the zinc produced in the State was more valuable than the gold, silver, and copper combined.

#### Montana

The value of the output of gold, silver, copper, lead and zinc from Montana mines in 1915 was nearly \$87,000,000, an increase of more than 81 per cent over the total value of the same metals in 1914, which was \$47,849,747, and is the greatest annual value of metals produced in Montana. There were increases in the output of all metals, but especially of lead and zinc. Though quantities show increases, the large increase in value was even more the result of a great rise in prices. The mine output of gold was valued at nearly \$5,000,000, against \$4,117,911 in 1914, an increase of over 21 per cent. The mine output of silver increased from 12,016,460 oz. in 1914 to about 14,500,000 oz. in 1915. This output shows an increase of nearly 21 per cent and is even greater than that of 1913, which was the record up to that time. Montana's greatest asset is copper, the output of which increased from 233,229,640 lb. in 1914 to nearly 275,000,000 lb. in 1915. This was an increase of nearly 18 per cent over 1914, but the output did not reach that of 1913. The mine output of lead increased considerably—from 9,656,008 lb. in 1914 to slightly over 14,000,000 lb. in 1915. This increase of over 45 per cent was due largely to the shipment of lead concentrates and of residues resulting from zinc smelting. The mine production of zinc increased from 111,

580,544 lb. (figured as spelter) in 1914, to 184,086,000 lb. in 1915. The spelter output represented an increase of nearly 61 per cent in quantity, but as the price of the metal increased from 6.30c. in January to 22.2c. in June there was an increase in the value of the output from \$5,690,608 in 1914 to over \$26,000,000 in 1915.

#### Nevada

The 1915 output of gold, silver, copper, lead and zinc from Nevada mines was approximately \$34,566,000. This represents an increase of nearly 18 per cent over the output of 1914, when metals valued at \$29,300,842 were produced. These estimates indicate a marked increase in zinc output, and increase in lead and copper yield, as compared with 1914. The copper production however was below that of 1913, when Nevada had a record output of over 90,000,000 lb. There was a slight increase in the gold production, but a decrease in silver. The production of gold was valued at about \$11,968,000, an increase of 4 per cent over the production of 1914. The silver production decreased from 15,455,491 oz. in 1914 to about 14,478,000 oz. in 1915. The mine production of copper increased from 60,986,450 lb. in 1914 to about 67,480,000 lb. in 1915, an increase of 10.6 per cent. The total value of the output, on account of the high average price in 1915, increased from \$8,111,198 to approximately \$11,708,000. The lead production increased from 12,809,655 lb. in 1914 to about 14,782,000 lb. in 1915, an increase of over 15 per cent. This output, however, is not as great as that of 1913, when over 16,000,000 lb. were produced. A great increase, nearly 62 per cent, was made in the mine output of zinc in Nevada, from 12,980,232 lb. of recoverable spelter in 1914 to over 21,000,000 lb. of the metal in 1915. As the price of the metal was abnormally high in 1915, the value of the output increased from \$661,992 to about \$2,993,000 in 1915.

#### New Mexico

The output of New Mexico mines for eleven months of 1915, with an estimate for December, indicates a yield of \$1,500,000 in gold, 2,032,000 oz. of silver, 3,951,000 lb. of lead, 72,000,000 lb. of copper, and 24,640,000 lb. of zinc (in terms of spelter and zinc in zinc oxide), as compared with \$1,171,696 in gold, 1,777,445 oz. of silver, 1,763,641 lb. of lead, 59,307,925 lb. of copper and 18,403,392 lb. of zinc in 1914. These preliminary figures show an increase of \$328,000 in gold, 255,000 oz. of silver, 2,186,000 lb. of lead, 12,674,000 lb. of copper, and 6,237,000 lb. of zinc. With higher values of metals, except for silver, the total value was \$18,277,000, against \$11,049,932 in 1914, an increase of \$7,226,660.

#### Oregon

Preliminary estimates of the output of metals from Oregon mines in 1915 show material increases over the figures of 1914 in both gold and copper, and slight decreases in yield of silver and lead. The gold yield for 1914 was \$1,591,461 and the estimate for 1915 is \$1,771,618, which is an increase of \$180,157 for 1915. The silver output for 1914 was 142,552 oz., and the estimate for 1915 is 136,033 oz., or 6519 oz. less. The yield of copper in 1914 was 39,248 lb., while the estimate for 1915 is 910,104 lb., an increase for 1915 of 870,856 lb.; and the yield of lead was 16,436 lb. in 1914, as compared with 6650 lb. in 1915, or 9786 lb. less.

#### South Dakota

The mine production of gold from South Dakota in 1915 was \$7,390,000, compared with \$7,333,508 in 1914, and that of silver was 193,000 oz., compared with 176,642 oz. in 1914. A nominal quantity of lead was produced. Since 1876 South Dakota has produced \$192,677,000 in gold, and 6,026,000 oz. of silver.



## Utah

Mines in Utah produced gold, silver, copper, lead and zinc in 1915 amounting in value to \$55,000,000. This represents an increase over the production in 1914 of nearly 50 per cent, or \$18,000,000. There was a considerable increase in all the metals. About one-fourth more ore was mined, increasing the total from 8,544,014 tons in 1914 to about 10,725,000 tons in 1915. The mine output of gold increased over 19 per cent—from \$3,265,347 in 1914 to \$3,908,000 in 1915. The mine production of silver increased from 11,154,916 oz. in 1914 to approximately 12,724,000 oz. in 1915, the increase amounting to 14 per cent in quantity and about \$169,000 in value. The copper output from Utah mines increased from 152,034,002 lb. in 1914 to about 182,589,000 lb. in 1915, the increase amounting to more than 20 per cent in quantity and about \$11,450,000 in value. The gain was made mostly by the Utah Copper mine at Bingham, which is credited with an increase of 34,207,552 lb. over the output of 1914. The mine production of lead increased from 171,323,137 lb. in 1914 to 219,098,000 lb. in 1915, or about 28 per cent. With the advance in prices, zinc ore was offered from many sources. The mine production of zinc recoverable as spelter aggregated 22,643,000 lb., valued at about \$3,224,000. This is an increase of about 41 per cent in quantity over the output of 1914, amounting to 15,989,267 lb.

## Washington

The value of the mine output of gold, silver, copper, lead and zinc in Washington decreased from \$809,767 in 1914 to approximately \$728,000 in 1915. There were increases in copper and lead, to the extent of a return to normal production. There were shipments of zinc ore, the first since 1911. The gold and silver mines, however, showed decreased output, especially in the Republic mining district. The mine production of gold, which is the most important metal of the State, decreased from \$557,173 in 1914 to about \$407,000 in 1915. The silver output decreased from 264,861 oz. in 1914 to about 220,000 oz. in 1915. The production of lead from ores sold or treated increased from 65,507 lb. in 1914 to about 230,000 lb. in 1915. The mine output of copper increased from 778,728 lb. in 1914 to about 915,000 lb. in 1915, or over 17 per cent. On account of the increased price of the metal, the value increased from \$103,571 to about \$159,000 in 1915. The production was not as great as the production of either 1913 or 1912. The zinc output was entirely from the Metaline district, Pend Oreille County, where the Lead-Zinc Company operated a 50-ton concentration mill the latter part of the year. Several hundred tons of sulphide concentrates were shipped, together with some carbonate ore.

## Synopsis of Recent Chemical and Metallurgical Literature

## Gold and Silver

**Hydrolysis of Cyanide and Value of Protective Alkali.**—In the July-August, 1915, issue of the *Journal of the Chem. Met. & Min. Soc. of S. Africa*, Dr. JAMES MOIR contributes some data on this subject, showing that, roughly speaking, the addition of alkali equal to one-tenth of the cyanide causes the recovery of 90 per cent of the lost cyanide. The hydrolysis of sodium cyanide in water is due to the weakness of HCN as an acid, resulting in NaOH and HCN existing uncombined in any solution of NaCN. The table gives the quantities and percentages of HCN and NaOH for any strength of total cyanide. Hydrolysis is less in the

presence of zinc cyanide, but the author does not know how much.

TABLE I

Hydrolysis of pure NaCN into HCN and NaOH at summer temperature. (Results 10 per cent to 15 per cent lower in winter.)  
Y = total cyanides per cent as KCN. x = part hydrolyzed to HCN, but calculated as KCN per cent. Z = part hydrolyzed to NaOH calculated as per cent NaOH.

Y	x	100x	Z	100Z
		Per Cent of Whole		Per Cent Total KCN
1.0	0.0077	(0.8)	0.0047	(0.5)
0.5	0.0054	(1.1)	0.0033	(0.7)
0.3	0.0042	(1.4)	0.0026	(0.9)
0.2	0.0034	(1.7)	0.0021	(1.1)
0.1	0.0024	(2.4)	0.0015	(1.5)
0.05	0.0017	(3.4)	0.00105	(2.1)
0.02	0.0011	(5.4)	0.0007	(3.3)
0.01	0.0008	(7.7)	0.0005	(4.7)
0.005	0.0005	(11)	0.00033	(6.7)
0.001	0.00024	(24)	0.00015	(15)

There is some doubt whether Clennell's process tried on pure KCN would indicate the alkalinity due to hydrolysis. Assuming that it does not do so, but only added alkalinity, the formula

$$x_1 = \frac{Y}{27,500(W + Z)}$$

gives the HCN (calculated as KCN) in presence of "Clennell-alkalinity" of W per cent. Thus if W = 0.01 per cent NaOH and Y = 0.5 per cent KCN, Z from above table is 0.0033, total alkalinity (W + Z) = 0.0133 and  $x_1 = 0.0014$  per cent (about one-quarter of hydrolysis in absence of NaOH, see x above). The following table has been constructed from this formula for all common strengths of cyanide.

TABLE II

Strength of Cyanide as KCN Per Cent	Observed Alkalinity as NaOH Per Cent	Amount of HCN Lost by Hydrolysis Calculated as Per Cent
0.2	0.03	0.00023
	0.02	0.00033
	0.01	0.00060
	0.005	0.00102
	0.002	0.00177
0.15	0.03	0.00017
	0.02	0.00025
	0.01	0.00046
	0.005	0.00080
	0.002	0.00144
0.10	0.03	0.00012
	0.02	0.00017
	0.01	0.00032
	0.005	0.00056
	0.002	0.00104
0.05	0.03	0.00006
	0.02	0.00009
	0.01	0.00016
	0.005	0.00030
	0.002	0.00060
0.02	0.03	0.000024
	0.02	0.000036
	0.01	0.000072
	0.005	0.000144
	0.002	0.000352

## Antimony

**Behavior of Stibnite in Oxidizing Roast.**—A study of the behavior of stibnite,  $\text{Sb}_2\text{S}_3$ , under the conditions of an oxidizing roast has been studied by H. O. HOFMAN and JOHN BLATCHFORD, who communicate their results in the January *Bulletin of the American Institute of Mining Engineers*. Certain difficulties inherent in stibnite are encountered in the oxidizing roast. It has a low melting point, 540 deg. to 550 deg. C., according to various authorities; the ignition point is still lower, the mineral beginning to oxidize at 290 deg. C. if the size of grain is 0.1 mm., and at 343 deg. and 430 deg. respectively for gains from 0.1 to 0.2 mm. and 2 mm.; a mixture of  $\text{Sb}_2\text{O}_3$  and  $\text{Sb}_2\text{S}_3$  is fusible at 517 deg. C.; both of the latter compounds are volatile at low temperatures.

The aim of the present investigation was to study the changes undergone by stibnite when roasted at

different temperatures; the composition of the roasted product; the losses which occur. The roasting furnace used was of the electric resistance type. The following table gives a summary of observations during the experiments.

Temperature, °C	Changes
196	Faint odor of $\text{SO}_2$ .
219	Litmus begins to turn pink.
281	Ore becomes dull; odor of $\text{SO}_2$ very distinct.
336	White ashes form on rabbling, and some $\text{Sb}_2\text{O}_3$ is evolved.
380	Lowest temperature at which odor of $\text{SO}_2$ disappears.
400	Ore becomes sticky if temperature is raised quickly.

The conclusions drawn by the authors are:

1. The ignition point of stibnite is approximately 200 deg. C., as evidenced by the odor of  $\text{SO}_2$  evolved and its action on litmus paper.
2. There is a sharp visible formation of  $\text{Sb}_2\text{O}_3$  at 336 deg. C. At this point white fumes are evolved.
3. The formation of  $\text{Sb}_2\text{O}_3$  takes place slowly, probably according to the reaction:



4. It is possible to eliminate all the sulphur slightly below 400 deg. C. without a large loss of antimony.
5. Stibnite is oxidized at first to antimony trioxide which begins to change to antimony tetroxide only when all the sulphide has been decomposed.
6. The amount of tetroxide increases as the trioxide decreases, the action being more rapid as the finishing temperature is raised.
7. The loss of antimony during the roast increases with the temperature.

**Determination of Antimony in Roasted Stibnite.**—In a paper to be presented at the February meeting of the American Institute of Mining Engineers, W. T. HALL and JOHN BLATCHFORD describe their methods for determining the condition of the antimony as well as the total quantity present in roasted stibnite. The roasted product may contain some unoxidized  $\text{Sb}_2\text{S}_3$  and a mixture of  $\text{Sb}_2\text{O}_3$  and  $\text{Sb}_2\text{O}_4$ .

Total antimony was determined as follows:

Weigh out 0.25 gram of the roasted product into a trapped flask, add 4 grams of powdered tartaric acid, 2 grams of potassium iodide and 40 c.c. of concentrated hydrochloric acid. Boil the solution gently for 5 minutes and then cool to room temperature by shaking the flask while holding it under running water. Then, very carefully discharge the iodine color by the cautious addition of 0.05-normal sodium thiosulphate solution, adding a little starch toward the last. Nearly neutralize the acid with ammonia solution, but leave the solution distinctly acid. Pour the slightly acid solution into 200 c.c. of water containing an excess of sodium bicarbonate and titrate to a permanent blue color with standard 0.1-normal iodine solution.

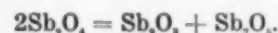
The determination of the unchanged antimony sulphide was accomplished by a method corresponding to that used in the determination of sulphur in steel. The sample was dissolved in concentrated hydrochloric acid, the escaping hydrogen sulphide absorbed in an ammoniacal cadmium chloride solution and the sulphur in the precipitated cadmium sulphide determined iodometrically.

Inasmuch as all the antimony present in the roasted stibnite was soluble in concentrated hydrochloric acid, the solution remaining in the evolution flask after the determination of the sulphur could be used for the determination of the trivalent antimony. The details of the procedure are as follows:

To the solution remaining in the evolution flask after the determination of the sulphur, add 4 grams of powdered tartaric acid and carefully dilute with 100 c.c. of water. Carefully add 6-normal ammonia solution until

the solution is only slightly acid and then pour the solution into a large beaker containing 5 grams of sodium bicarbonate in 200 c.c. of water. Titrate with 0.1-normal iodine solution as in the determination of the total antimony.

In computing the results, it is necessary to remember that antimony tetroxide may be regarded as antimonious antimonate:



Since antimony pentoxide changes to the tetroxide when heated above 300 deg., it is fair to assume that each atom of pentavalent antimony found in the analysis corresponds to one molecule of antimony tetroxide. Then from the total quantity of trivalent antimony found, deductions must be made for the amount of tetroxide and for the trisulphide as found by the sulphur determination, the balance is the trivalent antimony corresponding to the quantity of antimony trioxide present.

## Recent Chemical and Metallurgical Patents

**Silver-Palladium Alloy, Substitute for Platinum.**—An alloy for use in contact and spark devices to replace platinum is patented by Mr. PAUL R. HEYL of New Rochelle, N. Y. (assigned to Commercial Research Company of New York City). This alloy consists of silver and palladium in varying proportions according to the conditions under which it is to be used. An alloy of silver with 2 per cent of palladium has been found to give satisfactory results under many circumstances. When the contacts or spark points are exposed to sul-

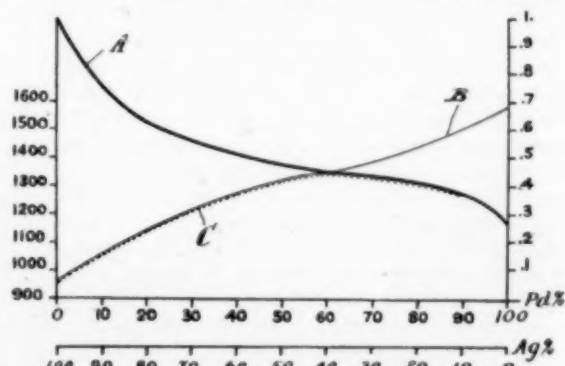


FIG. 1—SILVER-PALLADIUM SERIES

phur compounds 5 per cent or more of palladium should be used. The alloy which was found to give the greatest resistance to spark erosion was that of 60 per cent palladium and 40 per cent silver. Palladium has a higher melting point and lower thermal conductivity than silver, consequently additions of palladium to silver raise the melting point and lower the thermal conductivity. It has been found that, on account of the high thermal conductivity of silver, the heat from the spark will be conducted away fast enough to prevent melting of the silver. In view of this fact silver-palladium alloys with very high percentages of silver can be used in a great many cases. A diagram of the silver-palladium series is shown in Fig. 1. Curve B is the melting point curve, A is the thermal conductivity curve, and curve C (shown dotted) was constructed to illustrate the resistance to spark erosion, although this may vary under different conditions. The maximum resistance to spark erosion is seen to be at substantially 60 per cent of palladium and 40 per cent of silver. Different desirable degrees of softness may be obtained with these alloys (1,166,129, Dec. 28, 1915).

**Iron Alloy.**—An alloy possessing properties which will permit of its being used to produce cast chilled rolls



and sand rolls that possess an extremely hard surface and strong central portion is patented by HERBERT E. FIELD and FRED. C. T. DANIELS of Wheeling, W. Va. The chilled surface of rolls made of this alloy is claimed to be so hard that it cannot be machine finished, but must be finished by grinding machines, and the central portion will withstand shocks and strains even when heated in the hot working of iron and steel. The composition of the alloy is as follows: silicon, 0.250 to 1.50 per cent; sulphur, 0.025 to 0.20 per cent; phosphorus, 0.010 to 1.00 per cent; manganese, 1.50 to 3.50 per cent; carbon, 1.50 to 3.50 per cent, and iron to make 100 per cent. The alloy may also contain small quantities of other elements, such as vanadium, titanium, tungsten, copper, or cobalt. The alloy is made in the usual way (1,166,342, Dec. 28, 1915).

**Cathode Starting Sheets.**—In producing cathode starting sheets as in electrolytic copper refining it has been customary to make a scratch groove on both surfaces of the blank and at a short distance from the edges. This groove is made of sufficient depth to permit a skilled operator to detach the deposited starting sheet along the groove. The undetached metal between the grooves and the outside edges has to be scrapped and remelted. Considerable time is also required to remove these edge strips. Making a scratch groove on the edge did not obviate these difficulties as the metal bridged over the groove to such a degree as to firmly unite the deposits on the opposite sides of the blank. In order to do away with the expense of remelting the scrap, and also to provide an easily detachable starting sheet, a new method is patented by EDMOND A. GUGGENHEIM of New York. In this method an insulating material is placed in a recess all around the outer edges of the blank so as to prevent metal from depositing on this insulated section. The lower edge may or may not be insulated, but it is grooved in any case. Some of the insulating materials mentioned are asphaltum, asphaltum mastic and chatterton compound. The methods of insulating the side and bottom edges and of grooving the bottom edge are shown in Fig. 2 (1,163,337, Dec. 7, 1915).

**Electrolysis of Zinc Solutions.**—Addition of calcium carbonate to zinc chloride or zinc sulphate solutions is claimed to aid in the deposition of commercial metallic zinc, according to a patent of CLARENCE A. HALL of Mount Airy, Pa. The process does not require any marked departure from ordinary practice as to current density, and diaphragms are not necessary. Finely divided calcium carbonate in quantity sufficient to unite with the liberated sulphate or chlorine ions is added to the bath and kept in a suspended condition by agitating. It is claimed that this addition will prevent the deposition of mossy zinc (1,163,911, Dec. 14, 1915).

**Electric Furnace for Melting and Heat Treating.**—An electric furnace designed to reduce heat losses through radiation to the furnace walls is patented by JAMES M. LOHR and HORACE W. GILLET of Ithaca, N. Y. Several different styles of this furnace are mentioned, all embodying the same idea of subdividing the furnace into several compartments and using as heating elements the dividing partitions. Some of the styles described are a long, narrow furnace, a triangular-shaped furnace, and a furnace in the shape of an an-

nular ring. By dividing these furnaces into several compartments and using the dividing partitions as heating elements, the direct radiations from both sides of these elements will strike the crucible placed in the compartments, whereas in the old form of furnace one side of the heating element usually radiated heat directly to the furnace wall. The use of the idea has been generously thrown open to the public by the patentees (1,162,178, Nov. 30, 1915).

**Reverberatory Smelting Furnace.**—In Fig. 3 we illustrate a method of fettling reverberatory furnaces from hoppers placed along the sides of the furnace, patented by GEORGE C. CARSON of Denver, Colo. The

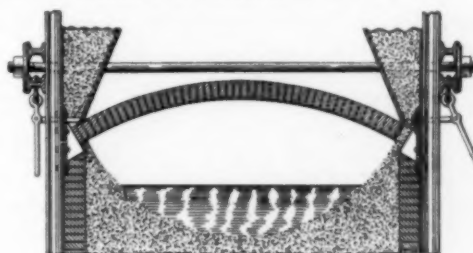


FIG. 3—REVERBERATORY FURNACE

object of the invention is to improve the former method of protecting the side walls of the furnace by hand-fettling or claying. According to the present invention, it is proposed to feed refractory material to the side walls by gravity from hoppers which are placed above the furnace and which have communication with the interior. (1,149,495, Aug. 10, 1915.)

**Roasting Furnace.**—A furnace structure patented by UTLEY WEDGE of Ardmore, Pa., is shown in elevation in Fig. 4. It has fixed annular walls 1 and 2, between which is a furnace chamber 3. Within the chamber is a series of superposed annular hearths, some of which, as at 4, are stationary and project from the walls, while others, as at 5, are rotatably mounted on

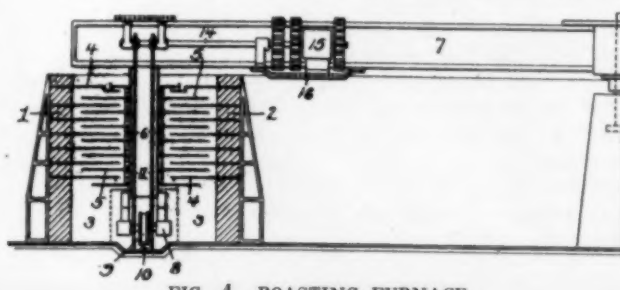


FIG. 4—ROASTING FURNACE

a structure 6 in the center of the roasting chamber. This structure is connected to the arms of a spider 7, which turns about an axis concentric with the annular structure of the furnace. The hearths have rabbles on their under sides for stirring and moving the ore on the hearth beneath. The annular structure 6 is composed of sections each provided with a pair of trucks 8 and wheels 9 which run on the track 10, and thus support the structure. Rotation of the spider is accomplished by power from a motor 15, communicated by a train of gearing and shaft 14 to drive chains 12, which turn the wheels 10. (1,159,141, Nov. 2, 1915.)

**Method of Cooling Roasted Ore.**—For the purpose of cooling the product of a preroasting furnace of the Godfrey type, which product is to be further treated by sinter-roasting, WILLIAM H. HUBBARD, JR., of Salida, Colo., has devised and patented apparatus which avoids the annoyance of dust and smoke and brings the ore into good physical condition for handling and further treatment. It consists of a circular table onto which

the hot ore is delivered and rabbled. The table may be rotatable and the rabbles stationary, or vice versa. (1,149,264, Aug. 10, 1915.)

### A Novel Cooler

Though the roasting of ore, cement clinker, etc., has received the closest attention and study, the after-cooling of hot, and oftentimes semi-molten, material has generally been left to the crudest of devices. Instead of special and ample space being reserved, the cooler is fitted as an afterthought into some corner or pit, and its design also receives slight attention. Imperfect cooling, followed by rapid vulcanizing of conveyor and elevator belts and injury to chemical solutions, inevitably takes place, not to speak of the power, repair parts, cooling water, grease, etc., wasted on a machine avoided by the attendants on account of poor location, dust and heat.

Recognizing this difficulty, the engineers of one of the largest users of roasters in the world, by experiment and investigation, systematically undertook its solution. The evolution of the "Baker" cooler, patented by Mr. F. D. Baker, chief engineer of the American Smelting & Refining Company, and illustrated above, is the direct result of this work.

Red-hot material is fed continuously through a cast-iron or steel spout into one of the cone-shaped ends of a steel cylinder. This cylinder is partly submerged in a bath of water contained in a concrete, rectangular tank. The amount of submergence is adjustable, and is carefully calculated so that the weight, not only of the cylinder, but also of its load of cooling material, floats on the water by displacement. Friction, and consequently power, is therefore reduced to a minimum, and end bearings are used only as guides and to prevent the cylinder rising in case the load is reduced.

The cylinder revolves very slowly and the hot material is advanced by means of plows. The heat is transmitted to the steel shell, which is an excellent conductor. Part of it immediately passes into the water-bath, but most effective absorption takes place on that part of the shell above the bath during the evaporation of its covering of water. In proportion to the total circumference the portion of the shell in contact with the hot material at any one time is small, therefore damage to the shell by overheating is impossible, as even during a shutdown it is water-jacketed.

Discharge is effected by means of a spiral which raises the cooled material to practically the same level

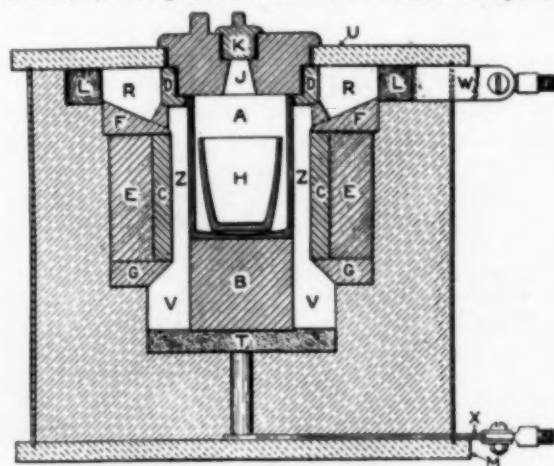
as it enters the cylinder, thereby conserving head room.

The final temperature is regulated by the rate of feed, by the peripheral speed of the cylinder, and by the angle and number of plow-blades.

Though originally designed for the cooling of roasted ores, the Baker cooler has been most successfully applied to the cooling of bauxite, soda-ash and other industrial materials. It is manufactured by the Stearns-Roger Mfg. Co. of Denver, Col.

### American Made Laboratory Glassware

A borosilicate glass, called pyrex, which was developed by the Corning Glass Works has proved itself equal to all demands made upon laboratory glassware. This glass possesses a very low coefficient of expansion (0.0000032) and great resistance to sudden temperature



HIGH-TEMPERATURE EXPERIMENTAL FURNACE

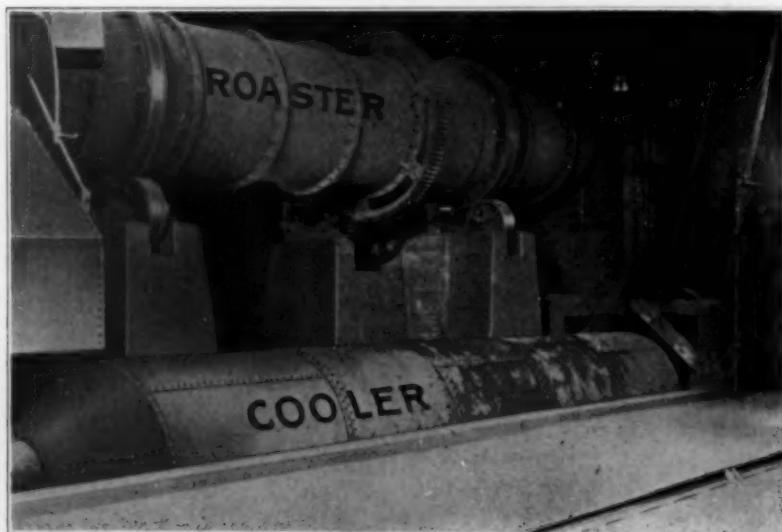
changes. Tests made on this glass show it to be less soluble in water and acids than the best glass heretofore made and about equally soluble in alkalies. On account of the low coefficient of expansion it has been possible to make the glassware with thicker walls than usual, thus adding to the mechanical strength. This glassware is handled in the east by Eimer & Amend in New York City and Arthur H. Thomas Co., Philadelphia, Pa.

### Experimental Electric Furnace for High Temperatures

An electric furnace which was designed primarily for determining the fusion point of coal ash, metals and alloys, but which has also found application in other experimental work is shown in section in the accompanying illustration. This furnace is known as the "High Temp" furnace and is sold by Eimer & Amend, New York City.

Under normal heats the furnace reaches 1600 deg. C. in about one hour and has a maximum temperature limit of 1800 deg. C. Referring to the illustration, Z represents the heating zone formed by two concentric cylinders A and B inside, and C outside the zone. A special granular resistor material is used which is placed in the chambers R, Z and V. The portions R and V have large area and lower resistance than V, consequently the heat is concentrated in the zone Z.

Graphite electrodes are shown at L and T. These form contact with the granular resistor material. The resistor material is gradually replaced as it is used up.



COOLER

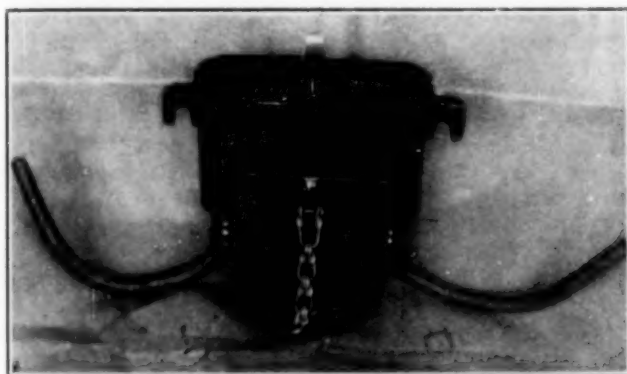


A demonstration of one of these furnaces was made at the National Exposition of Chemical Industries held last September in New York. A furnace was run continuously for a week on one charge of granular resistor material.

The furnace operates on either alternating or direct current up to 125 volts and the size of heating chamber is  $2\frac{1}{4}$  in. diameter and  $3\frac{3}{4}$  in. deep. All refractory parts are replaceable.

### A Special Cut-Out

In localities where the atmosphere is highly charged with impurities much inconvenience and expense has always been experienced on account of the ordinary porcelain cut-outs protecting pole-type transformers blowing unexpectedly for no apparent reason. Investigation has shown that the porcelain type of cut-out cannot be prevented from absorbing a certain amount



CUT-OUT

of volatile matter and condensation from the air. In many cases this condensation is of a virulent nature and in short time the metallic fuse element corrodes to such an extent that its current-carrying capacity is reduced until the fuse blows far below its normal rating. The result is that one or whole installations of motors are shut down inadvertently, always at considerable inconvenience and frequently heavy expense for damaged product and reduced output. This matter has become of such importance in some localities where atmospheric conditions are particularly unfavorable that the transformers have been housed indoors, necessitating additional cost for the building as well as the occupation of space; in other instances circuit breakers have been installed on the poles for the sole purpose of obviating the corrosion of the fuse by chemicals in the air.

For several years the Chemelectric Company, 4327 Kenmore Avenue, Chicago, have been installing their S & H oil immersed cut-out for the protection of some very large trans-



CUT-OUT

former banks supplying by-product plants, steel mills, furnaces, etc., where the deleterious influences are particularly severe, with entire success. The S & H oil immersed cut-out is similar in principle to the high-capacity cut-out of this firm, with the addition that the whole unit is completely immersed in oil contained in a non-corroding metallic case. The cut-out has a rating of 250 amp. at 2400 volts, which is capable of handling the largest distributing transformer yet built. This cut-out is absolutely immune from the chemical influences in the air in the open or underground, and gives reliable protection with the maximum of simplicity and the minimum of expense in first cost and upkeep. It has the reliability and ruggedness of the circuit breaker at a fraction of the price.

### Fifth Annual Report, Director of the Bureau of Mines

The report of the Director of the United States Bureau of Mines for the fiscal year ended June 30, 1915, contains a résumé of the work of the several departments of the bureau and sets forth the needs for the extension of the work.

In the division of mineral technology the principal investigations have related to the treatment of ores containing uranium, vanadium and radium, tungsten, platinum, thorium and mesothorium, molybdenum. Non-ferrous alloys received considerable attention, and the clay industry was the subject of some investigations.

The metallurgical division continued its investigations of smelter smoke and certain metallurgical processes relating to the recovery of sulphur from ores. The hydrometallurgy of gold and silver ores was carried on through co-operation with the Nevada Mine Owners' Association. The standardization of cyanide tests was begun. The treatment of low-grade complex sulphide ores was investigated in conjunction with the University of Utah. The smelting of titaniferous iron ores was the subject of investigation at Port Henry, N. Y. The zinc and lead ores of Kansas, Missouri, Illinois and Wisconsin were studied with special reference to losses in milling and smelting.

In the petroleum division the principal work was done on the cracking of petroleum and the conservation of natural gas.

The general research laboratory studied the methods of sampling and assaying ores and metals.

### Non-Ferrous Metal Market

Jan. 26.—Price changes have been small during the last two weeks, but for the most part have shown an advancing tendency; in fact, practically all of the metals have advanced since our last report. Producers all seem to be in a very strong position and periods of dullness have no effect whatever on the market. There are those who still think the market is resting on a false bottom, but the refusal of the producers to sell or quote early deliveries even to their best friends in some cases seems to repudiate this supposition.

**Copper.**—The situation in this metal is without precedent, and January and February deliveries are hard to get. The market is strong and 25 to  $25\frac{1}{2}$  cents is asked for electrolytic and Lake. Buyers are scared and sellers are shy. Shipping facilities were badly tied up in New England about Jan. 17, and whether they are better now or not cannot be stated. The strike in Arizona was ended on Jan. 24, and early in February normal conditions should be resumed.

**Tin.**—Aside from a little excitement on Jan. 15,

when no cable advices were received from London, the market has been somewhat dull and featureless. Prices have remained firm, however, with a slight rise in the last few days so that Straits tin is now quoted at 42.25. Imports are fairly good so far this month.

**Lead.**—In spite of an apparently dull market the Trust price was advanced to 6.10 on Jan. 21. This is the continuation of a steady advance started last September. It is understood that some large bids at 6.05 have been refused, and it is evident that lead is in a strong position.

**Spelter.**—Early deliveries have been in very good demand and the market has been strong with prices considerably higher. January, February and March deliveries are much sought for. Current prices quoted range from 19.00 to 19.30 at New York.

**Other Metals.**—Aluminium has remained dull with prices quoted at 53.00-55.00. Antimony has met with better demand during the last week, and American, Chinese and Japanese brands are quoted at 42.50-43.00. Platinum prices are still entirely nominal at \$88 to \$100 per ounce. Silver is quoted at 57½, a new high for the movement, and quicksilver doesn't know where to stop, being quoted at \$275 per flask.

### The Iron and Steel Market

Developments in January served to differentiate the steel market movement from its predecessors. It seems certainly more than a coincidence that the three great market movements of the past dozen years met their ends at the year-end. In 1907, 1910 and 1913, years following periods of heavy buying, the mills ran chiefly on their accumulations of orders. The high points in the unfilled obligations reported by the United States Steel Corporation fell on Dec. 31 of 1906, 1909 and 1912 respectively. A reasonable explanation of the phenomenon is that perforce the market experiences a lull at the holidays and unless it has an exceptionally strong undertone it fails to recover its gait. There were no heavy price advances in 1907, 1910 or 1913, though advances had continued almost to the opening of those years.

The difference this year is that in January steel prices have risen at practically the same rate as in the three months preceding. Four of the most important groups of finished steel products, bars, plates, shapes and tubular goods, experienced two advances in January, while tin plates and wire products each experienced one advance. While black sheets did not advance there was an advance in blue annealed sheets.

Strictly new buying of steel products is in general at a greatly reduced rate. The large business transacted may be regarded as of a routine character. There is very heavy specifying against current contracts, nearly all of which are at much lower prices than now quoted. There is a fair volume of contracting for bars, plates and shapes for third quarter, representing merely the fact that mills have now opened their books, in conservative fashion, for that period. The buyers would have placed their contracts earlier if permitted. There is heavy buying of war material, the tonnage running chiefly into large rounds for shells, but this business in general represents buying for second half shipment, following contracts placed long ago for first half. The production of war material promises to be at a substantially unchanged rate.

As the mills entered the year with a very large volume of specifications, averaging throughout the industry about the equivalent of three months of full production, there is no occasion for much concern as to the ability to operate throughout the year up to the physical limits. The buyers who have furnished the specifications now in hand are, as a rule, ready to furnish additional speci-

fications faster than they can be filled. While strictly new buying is light there is always some new business coming up that will be placed irrespective of the fact that prices are relatively high.

The problem of the steel mill this year is really not one of markets or of sales, but of production and transport. Labor is scarce, despite the general wage advance of about 13 per cent effective Feb. 1, and is likely to grow scarcer, both because immigration is practically shut off and because when spring opens outdoor work will make some drain upon inside operations. The question of transportation has grown more serious. Until very recently the shipment of steel from mills was interfered with only as to destination. New England was embargoed, and little steel was accepted for shipment East for export. The mill output could, however, be shipped elsewhere. Cars have been growing scarce in the past fortnight, and a number of mills have accumulated steel awaiting shipment. In the week beginning Jan. 17 the car supply in the Connellsville coke region averaged about 50 per cent of requirements, curtailing shipments by that amount and the movement of coke in transit became less rapid, so that coke receipts at blast furnaces were greatly reduced. Many had slight accumulations, but many furnaces had to be slowed down. The more heroic operation of banking did not have to be resorted to except perhaps in rare instances, but the country's pig-iron output for the month was probably reduced several per cent. Strenuous efforts made by the railroads resulted in an almost normal supply of coke cars the following week.

The Steel Corporation directors at their meeting Jan. 25 declared a dividend of 1¼ per cent on the common stock, thus restoring the old rate. As the earnings for the December quarter were \$51,300,000, the dividend, amounting to less than \$6,400,000, absorbed less than one-fourth the earnings left after the regular charges, including preferred dividend, were met. Wall Street, however, had been in some doubt whether a dividend would be declared. Inasmuch as the major portion of the advances in the steel market have occurred since Oct. 1, the shipments during the December quarter were at relatively low prices. Excluding standard steel rails, the price of which has not changed for many years, the shipments in the December quarter may be estimated to have been invoiced at about \$12 a ton below the prices now ruling in the open market for shipment at mill convenience. As the shipments in the quarter were about 3,750,000 tons, the average profit per ton, after making an allowance from the reported earnings for profits in ore transportation, was slightly in excess of \$13. The possibilities of earnings in future are therefore astonishing. Production costs are necessarily rising from a variety of influences, one of the more important of many being the general wage advance averaging perhaps 13 per cent which is being made, and which becomes effective in most instances on Feb. 1.

### Pig Iron

The pig-iron market has shown no more activity in the second half of January than in the first half. Most observers regard the quietness as phenomenal in the circumstances. The psychology of the situation seems to be that the extremely strong steel market caused pig-iron consumers to cover liberally in recent months, while at the same time it encouraged furnaces to advance prices sharply, producing a price level at which buyers hesitate to make further commitments when they are well covered for a moderate period. The total advances in pig iron from the low level of the early months of last year is between \$5 and \$6 a ton, and the profits of the best-positioned furnaces as to low-



cost operation would be extremely large if they were shipping their entire current make at the existing market prices. Any further advance in pig iron must occur through an actual and serious scarcity being developed. Evidently the buyers feel it the conservative course to take their chances with the conditions when they show signs of arising. The market has been practically stationary for a month. We quote: No. 2 foundry iron, delivered Philadelphia, \$19.75 to \$20.25; f.o.b. furnace, Buffalo, \$18 to \$18.50; delivered Cleveland, \$18.80; f.o.b. furnace, Chicago, \$18.50; f.o.b. Birmingham, \$15 to \$15.50; f.o.b. valley furnaces, 95c. higher delivered Pittsburgh: Bessemer, \$21; basic, malleable and forge, \$18 to \$18.50; No. 2 foundry, \$18.50 to \$19.

### Steel

The market for soft steel billets and sheet bars is quotable at about \$32 to \$33 for Bessemer and \$35 for open-hearth, f.o.b. maker's mill, Pittsburgh or Youngstown, but the quotations are practically nominal. Regular consumers have contracts at lower prices, and while deliveries are not in all instances fully up to requirements, prices being obtained on ordinary finished steel products do not justify paying prices that would be asked on fresh transactions. Forging billets made to war specifications are bringing usually between \$50 and \$55. A sale of 4000 tons of rods for February and March shipment is reported at \$55, but the market for ordinary deliveries is quoted at \$42 to \$44, though such figures are regarded as largely nominal.

### Finished Steel

About Jan. 21 plates were advanced \$3 a ton to 2.00c. and bars and shapes \$1 a ton to 1.90c. Effective Jan. 24 wire products were advanced \$2 a ton, woven wire fencing being advanced three points to 64½ per cent off list. Regular mill prices are given below, f.o.b. Pittsburgh, unless otherwise noted, and are for delivery at mill convenience, higher prices ruling for early shipment of some products, particularly bars, plates and blue annealed sheets.

Rails, standard sections, 1.25c. for Bessemer, 1.34c. for open-hearth, f.o.b. mill, except Colorado.

Plates, tank quality, 2.00c.

Shapes, 1.90c.

Steel bars and bands, 1.90c., base; steel hoops, 2.10c., base.

Iron bars, Philadelphia, 2.259c. to 2.359c.; Chicago, 1.75c. to 1.80c.; refined iron bars, Pittsburgh, 2.00c. to 2.10c.

Plain wire, 2.05c., base; galvanized wire, 1.75c.; wire nails, \$2.20 per keg, base; painted barb wire, 2.35c.; galvanized barb wire, 3.05c.

Sheets, blue annealed, 10-gage, 2.65c. for Bessemer, 2.75c. for open-hearth; black, 28-gage, 2.60c. for Bessemer, 2.60c. to 2.70c. for open-hearth; galvanized, 28-gage, 4.75c. to 5.00c.; painted corrugated, 28-gage, 2.80c.; galvanized corrugated, 28-gage, 4.80c. to 5.05c.

Tin plate, \$3.75 for 100-lb. cokes.

Steel pipe, ¾ to 3-in., black, 76 per cent off list; galvanized, 60½ per cent off list.

Boiler tubes (less than carloads), 3½ to 4½-in., 64 per cent off list.

Structural rivets, 2.60c.; boiler rivets, 2.70c.; cold-rolled shafting, 45 per cent off list; cold-rolled strip steel, 3.75c. to 4.00c., base.

**Titanium Production in 1915.**—During 1915 the American Rutile Co. produced 250 tons of rutile worth between \$25,000 and \$30,000 at its plant at Roseland, Va., according to the Geological Survey. This is the largest production to date.

## Digest of Electrochemical U. S. Patents

PRIOR TO 1903

*Arranged according to subject-matter and in chronological order.*

*Compiled by Byrnes, Townsend & Brickenstein, Patent Lawyers, National Union Building, Washington, D. C.*

### Aqueous Bath Apparatus

(Continued)

512,417, Jan. 9, 1894, Charles N. Waite of Newton, Mass.

Relates to an insulated joint between sections of a metallic conduit, generally a lead pipe, for conducting chlorine gas from the anode compartment of an electrolytic cell. One end of a conduit section is enlarged to a cup-shaped receptacle for the end of another section of the conduit; within the cup-shaped receptacle and surrounding the inner pipe-end is an asbestos washer, and above the asbestos washer is poured melted Trinidad asphalt or other suitable cement not affected by chlorine.

512,970, Jan. 16, 1894, John P. Johanson of New York, N. Y.

Relates to an electric washing apparatus, which is said to aid in the cleaning of soiled clothing during the operation of washing. It consists of a pair of electrodes connected by a flexible conductor to a source of low voltage current; the electrodes are provided with insulated handles and hooks, by means of which they are hung from the edge of the ordinary metal wash-boiler in which they are suspended during the boiling of the clothes in soapy water.

522,619, July 10, 1894, Isaiah L. Roberts of Brooklyn, N. Y.

Relates to an electrolytic-decomposition tank made of iron or like metal, that may serve as the cathode. The anode consists of a carbon rod placed within a bag of pulverized anthracite coal, the coal serving as a diaphragm. The anode may when desired consist of other material than carbon, and the coal dust diaphragm may be retained by other means than by a bag. In practice, a large iron tank is used with a plurality of anodes; the tank is subdivided into small units by placing upright pieces of angle iron, so as to produce separate cells for each anode, the joints between the several angle irons being loose, thereby enabling a circulation of the electrolyte.

523,099, July 17, 1894, Clarence M. Barber of Cleveland, Ohio.

Relates to an apparatus for electroplating a large number of separate articles, such as arc light carbons, and consists of an endless conveyor, such as a pair of sprocket chains connected together by parallel links or bars so as to produce a unitary conveyor. Each of the parallel connecting links carries a clamp to support an article to be electroplated, automatic means being provided to fill and empty the clamps, and to immerse and remove the articles into and from the plating vats. The patent should be consulted for details.

550,812, Dec. 3, 1895, Elbert R. Allen of Wallingford, Conn., assignor to Simpson, Hall, Miller & Co. of same place.

Relates to a holder to support spoons, forks, etc., to receive an additional deposit upon the surfaces which are subjected to the most wear. The support consists of a long horizontal clamp made of superimposed clamping bars, the support mounted at its ends upon two upright rocking arms, which enables the tilting of the article to be plated, as a spoon, which is ordinarily clamped at the center, either to one side or the other, to vary the surface immersed.

553,732, Jan. 28, 1896, James H. George of New York, N. Y.

Relates to baths or tanks for electroplating such surfaces as the sides of the hull of a ship. The bath or tank is trough-shaped, and consists of a more or less flexible material such as papier-maché. The tank has broad, flange-like, concave edges, and is held against the side of a ship by suitable shore-pieces; the air is then exhausted from the tank by an air pump which maintains the exhaustion as long as the tank is in use. Suitable electrolytes are allowed to flow into the tank after it is in place, through one or more openings controlled by valves. The patent contains a reference to U. S. patent 498,707.

556,854, March 24, 1896, John Leith of St. Helen's, England, assignor to the Electrochemical Company, Limited, of same place.

Relates to conductors for supplying current to a number of electrolytic cells, or units of current consumption. The conductor consists of a cable made of a plurality of separate insulated wires, each wire supplying the anodes of one vat or cell, a duplicate cable supplying the cathodes of each cell, there being as many separate insulated wires to a cable as there are cells or units. With a long row of cells, the diameter of the cable will diminish from the first to the last, due to the reduced number of wires in the cable as the distance increases, thereby effecting an economy in copper over the practice of using a conductor of the same diameter along the row of cells.

563,972, July 14, 1896, Rudolf Kroseberg and Eugen Straub of Berlin, Germany, assignors to said Kroseberg.

Relates to electrolytic cells in which hollow electrodes are used. The hollow electrode may constitute a cell in that it consists of an anode and a cathode secured to the sides of an annular insulating member, the latter provided with an inlet and outlet for electrolyte. Several of such complete hollow cells are placed in a larger cell containing a liquid maintained at a desired temperature, thus assuring electrolysis under desired conditions. The patent also states that a liquid of any desired temperature may be caused to circulate through the hollow cells, and electrolysis takes place in the outer larger cell.

565,953, Aug. 18, 1896, Emile Andreoli of London, England.

Relates to an apparatus in which is carried out a process of so-called indirect electrolysis. The apparatus consists of a three-compartment cell, containing two porous diaphragms. The outer compartments constitute anode and cathode compartments, the inner compartment contains the electrolyte to be subjected to the indirect electrolysis. The apparatus may be used for preparing hydrosulphite of sodium as follows: In the anode compartment is placed a caustic potash (probably caustic soda) solution, and in the negative compartment a sodium chloride solution. In the central compartment is placed a solution of bisulphite of sodium, and immersed therein, but unconnected to the electric circuit, are immersed pieces of zinc in the form of gauze, perforated sheets, etc. During the passage of the current, the indirect electrolysis reduces the sodium bisulphite to sodium hydrosulphite. The sodium bisulphite solution may continuously circulate through several such tanks, and then through a bleaching tank, then through the electric cells. The apparatus may also be used to deposit gold and silver from their solutions, in which case the pieces of metal in the central compartment may contact with a layer of mercury at the bottom to maintain an amalgamated surface.

565,975, Aug. 18, 1896, James H. George of New York, N. Y.

Relates to apparatus for electroplating the sides of

vessels, and contains a reference to U. S. patent 498,707, and to a co-pending application Serial No. 527,916. The present patent relates to a system of supply and drain pipes to circulate the electrolyte to detachable vats temporarily secured on the sides of the vessel. The pipe system constitutes a closed circulating system in which the electrolyte passes through several detachable vats, and through a tank which maintains the electrolyte at the proper strength.

### Personal

Mr. D. B. W. Alexander has changed his address from the General Petroleum Co., Los Angeles, Cal., to the Barber Asphalt Paving Co., Maurer, N. J.

Mr. William Bjorkstedt has resigned his position with the electric furnace department of the Siemens & Halske Co., and has accepted the position of works manager of the Stavanger Electro-Staalverk in Stavanger, Norway.

Mr. P. A. Boeck of the Kieselguhr Company of America delivered an illustrated lecture on "High Temperature Insulation" before the Chicago Section of the American Society of Mechanical Engineers on Jan. 14.

Dr. F. G. Cottrell has been appointed chief metallurgist of the U. S. Bureau of Mines and will be located at Washington, D. C.

Dr. Saul Dushman of the General Electric Co. Research Laboratory and formerly of the Chemical Department of Toronto University, presented recently an illustrated lecture on "Electrons, Atoms and Energy Quanta," before the Niagara Falls Section of the American Electrochemical Society. This was followed by a review of the papers given in the past year, in which the entire section participated. The annual election was held at the same meeting and the same officers re-elected.

Mr. H. A. Guess has returned to New York after an extended trip to Chile, during which he visited the Braden and Chuquicamata properties.

The Colorado section of the A. I. M. E. elected the following officers at the annual meeting, Jan. 7: Chairman, L. P. Hammond; vice-chairman, F. H. Bostwick; secretary-treasurer, P. M. McHugh; directors, G. A. Kennedy and M. S. MacCarthy.

The marriage is announced of Mr. A. M. McAfee of the Gulf Refining Company, of Port Arthur, Tex., to Miss Marguerite Avelette Calfee, of Uvalde, Tex., on Jan. 11, 1916. Mr. McAfee is probably best known through his aluminum chloride process for the production of gasoline from high-boiling petroleum oils. A paper by him on this subject was published in our issue of Sept. 15, 1915.

Mr. Clarence W. Marsh, well known through his twelve years' connection with the Development & Funding Co. and the Hooker Electrochemical Co., as chief engineer and special investigator and a director, has opened offices as an independent consulting and chemical engineer at 201 Devonshire Street, Boston, Mass.

Dr. John A. Mathews, president of the Halcomb Steel Co. of Syracuse, N. Y., lectured on Jan. 14 before the Chicago Section of the American Institute of Mining Engineers on "Iron in Antiquity and To-day." The address was illustrated with numerous lantern slides made from historic cuts and illustrations from Dr. Mathews' private library, which contains many rare and old volumes, the oldest dating back to the year 1540.

Mr. Carl A. Nowak has changed his address from Manitowoc, Wis., to St. Louis, Mo., where he will be located at 2027 Railway Exchange Building.



The newly elected officers of the Colorado Scientific Society are: **H. C. Parmelee**, president; **T. B. Stearns**, first vice-president; **F. E. Shepard**, second vice-president; **A. J. Hoskin**, secretary; **J. W. Richards**, treasurer; **S. A. Ionides** and **V. G. Hills**, members of the executive committee.

**Mr. F. E. Pierce** presented a paper on "The Zinc Smelter of To-day" before the annual meeting of the metallurgical and mining section of the Engineers' Society of Western Pennsylvania on Jan. 25.

**Mr. R. E. H. Pomeroy**, superintendent of the Steptoe smelter of the Nevada Cons. Copper Co., has been visiting at Anaconda and Great Falls.

**Mr. John H. Rickard** is superintendent of the antimony smelter near San Francisco.

**Mr. J. M. Mitchell Roberts**, metallurgist for the Seoul Mining Co., Korea, is on a visit in California.

### Obituary

**Florentine J. Machalske**, an electrochemist, died at Plattsburgh, N. Y., on Jan. 16. Since November 1912 he had been experimenting with a new electric-furnace process for manufacturing steel.

**B. E. Sperry**, president of D. R. Sperry & Co., Batavia, Ill., died on Jan. 5, after an illness of about three weeks. He was sixty-three years of age and had been associated with his company since his eighteenth year. He filled the position of president for nearly a quarter of a century, and during that time the company's business greatly increased. He was the original inventor and designer of the well-known Sperry filter-press, the Sperry patent filter plate and the switch cock and double gutter system of filtration. Another of his inventions consists of the Sperry swing kettle vacuum pan, an ingenious and convenient type of machine found in many branches of the chemical industry. Due to his efforts a complete line of caldrons suitable for farm and industrial uses was developed. He was born in Malone, N. Y., and leaves a widow, five daughters and one son.

**William Barker Ruggles**, founder and president of the Ruggles-Coles Engineering Company, of New York City, died on Jan. 23 of pneumonia at the age of fifty-four years. He was born at Bath, N. Y., and a graduate of Cornell University. At the time of his death he was president of the Ruggles-Coles Engineering Company, the Novella Cement Company (Guatemala City, C. A.) and the Niagara Cement Company, and a director and the consulting engineer of the Buffalo Cement and Potash Corporation. He was the inventor of the Ruggles-Coles double-shell dryer and of many other engineering devices. He was a member of the American Society of Mechanical Engineers, Engineers' Club, Machinery Club, Cornell University Club and Psi Upsilon Club, and a trustee of Trinity Episcopal Church of Bayonne, N. J., where he had resided for twenty-four years. He had a wide circle of acquaintances among the members of the engineering profession and was highly respected as an able engineer and kind and genial man. He is survived by a widow and one daughter.

**John Alexander Hill**, president of the Hill Publishing Company, died suddenly from heart disease on Monday morning, Jan. 24, while traveling in his motor car from his residence in East Orange, N. J., to his place of business in New York City, at the age of 57 years. In John Hill one of the two or three great "captains of industry" in modern American technical journalism has gone into eternity—a typical American self-made man. He was an apprentice in a country

printing office at 14, a locomotive engineer on the Denver & Rio Grande at 20, founder and editor of the *Daily Press* of Pueblo, Colo., at 27. His connection with technical journalism dates from the time when as locomotive engineer he contributed stories of the railroads and "Jim Skeevers Object Lessons" to *Locomotive Engineering*. In 1888 he was called to New York to take charge of this paper and became part owner, but sold his interest in 1896 to purchase the *American Machinist*. In 1902 he bought *Power* and organized the Hill Publishing Company, which has since acquired the *Engineering and Mining Journal*, *Engineering News* and established the *Coal Age*. Mr. Hill is credited with



THE LATE JOHN A. HILL

many achievements in the business of publishing technical journals. A fine monument to his life and work is the Hill Building at Tenth Avenue and Thirty-sixth Street, New York, the home of his papers. Completed in 1914, it is a magnificent structure, equipped with all imaginable mechanical devices—many of his own design—to expedite work and safeguard employees. His ideal of a printing plant was that it should be as dainty and as cleanly as any business office. Accordingly the linotype machines are enameled in white and the composing rooms, the entire engine-room fixtures and the frames of the great presses and binding machines have a similar enamel finish. His life and work has left permanent marks on technical journalism. He was a genial man, fond of companionship and loyal to his friends and to every one of his employees. They placed a tablet to him in his new building still in his lifetime. It reads: "Within this monument to independent truth and service in engineering journalism the employees of the Hill Publishing Company have placed this tablet—an appreciation of the man and employer, John A. Hill."

### Industrial Notes

**New Utah Acid Plant.**—A new sulphuric acid plant to make 100 tons of acid per day is contemplated by the American Smelting & Refining Co. The exact site has not yet been decided upon, but it will likely be somewhere in the Salt Lake Valley.

**The Southern Electrochemical Co.** will begin operations shortly at its plant in Great Falls, S. C. Nitric acid will be produced from the air by the Pauling process. Power will be derived from the Catawba River. The present output will be about 4 tons of acid per day.

**The New Castle Rubber Company**, New Castle, Pa., will increase its capital stock from \$500,000 to \$1,000,000 by a vote of the stockholders. Large additions to the plant will be made.

**Benzol and Toluol Production.**—Production estimates in this new American industry should prove interesting. According to returns to the Geological Survey, the indicated production was 13,942,763 gal., in connection with which there was produced 761,256 lb. of naphthalene. By the end of 1915 there were nineteen new plants in operation recovering benzol and others in the course of erection. Before the war there was but one plant in operation. Some of the plants are not equipped to separate the different oils in the crude, and over 7,000,000 gal. was reported as crude and was shipped to refineries. In the 6,620,093 gal. refined at the place of recovery, there were 4,833,939 gal. of 100 per cent benzol, 1,315,727 gal. of toluol and 470,425 gal. of solvent naphtha. Thirty-one coke-making establishments, with 4993 by-product ovens, contributed to this total, and it is estimated that between 8,000,000 and 9,000,000 tons of coal was carbonized in the ovens. The annual capacity of the benzol-recovery plants now in operation is estimated at over 20,000,000 gal., and with new plants being constructed it will probably reach 22,000,000 gal. This enormous production is much greater than the normal consumption, but it is possible that new uses may be found for it after the war.

**Tungsten Production in 1915.**—Preliminary returns to the Geological Survey indicate that the production of tungsten ores in 1915 broke the record and that about 2165 tons of concentrates, carrying 60 per cent WO<sub>3</sub>, was produced. This had a value of about \$2,000,000. The largest previous output was in 1910, when 1821 tons was produced. The price in the early part of 1915 went as low as \$5.80 per unit. In the fall unheard prices were reached and up to \$50 and higher per unit was paid for tungsten concentrates. Prospecting did not follow at once as the prices moved so rapidly, but early in the fall considerable prospecting was in progress. Mills were erected by the Primos Chemical Co. at Dragon and by the National Tungsten Co. at Ari-vaca, Ariz., to treat the tungsten ores.

**Antimony Production in 1915.**—According to preliminary figures collected for the Geological Survey, the production of antimony ores in the United States is estimated to have been about 5000 tons, containing 2000 tons of antimony valued at \$325,000. Practically all operations of the past year were new, most were small, and they were widely scattered, so it is difficult to obtain exact figures so soon after the close of the year.

**New Uses of Monel Metal.**—In our Jan. 15 issue, page 110, in the article under this title mention was made and an illustration shown of a large valve for superheated steam service weighing 3500 lb. made by the Nelson Valve Co., Philadelphia, Pa. This was stated to be a Monel metal valve, but in order to correct any misconception, it should be stated that it is a cast-steel valve, the body having cast Monel seat rings and the bonnet a Monel "pack-when-open" bushing. The valve is of solid wedge type, the wedge being cast in one piece of Monel metal and the stem also made of Monel metal.

**The American Blower Co.,** Detroit, Mich., has sent us its latest edition of *Sirocco Service*, the little pamphlet devoted to blowers. This pamphlet describes various uses for Sirocco blowers.

**The Anaconda Copper Mining Co.** has placed an order for six more 10-ft. diameter by 4-ft. cylindrical length Hardinge ball-pebble mills making a total of fifty-six conical mills for its new plant. The Hardinge company reports that the ten mills are direct connected herringbone-gear driven, operating with 75 per cent less power than originally estimated.

At the annual meeting of the stockholders of the **American Metal Products Company,** Milwaukee, Wis.,

makers of Ampco bronze, the old board of directors was re-elected as follows: Peter J. Weber, president; Henry E. Berlie, vice-president; Wm. J. Eberle, secretary and treasurer; Richard Gaertner, manager, and Charles E. Helm and August Littmann. Action was taken to secure a larger plant for the increased business of the company.

**The Bailey Meter Company** has been incorporated under the laws of Massachusetts for the manufacture of recording meters and instruments for power plants and general use. The new company will be in charge of Mr. E. G. Bailey, and will be located at 141 Milk Street, Boston.

**Cyanamid Works.**—At the end of Mr. W. S. Landis' paper in our issue of Jan. 15 (pages 87 to 90) the place of the American Cyanamid Company was given as Niagara Falls, N. Y., which should read Niagara Falls, Ont., where the company's manufacturing plant is located. The general offices are at 200 Fifth Avenue, New York City, and division sales offices are maintained at Atlanta, Ga., and San Francisco, Cal.

**Adjustable-Pressure Centrifugal Pump.**—A centrifugal pump has recently been placed on the market by the Karl Kiefer Machine Co., Cincinnati, Ohio, which has a pressure adjusting arrangement by which any pressure may be secured from practically nothing up to 35 lb., depending on the size of the pump. It is intended to be used especially with filters or filling machines where the adjustable pressure is a desirable feature.

**The Miller Smelting & Refining Co.,** Cleveland, Ohio, assayer, smelter and refiner of gold, silver and platinum, announces that it is now located in the Ellastone Building, East Fourth Street and Prospect Avenue. Its old location at 612 Euclid Avenue was burned out.

**The Palo Company,** New York City, announces its entrance into the laboratory supply and assayer's material business, with headquarters at 90-94 Maiden Lane. It has issued a catalog describing biological, bacteriological, chemical, physical, metallurgical, optical and astronomical apparatus.

**The Quigley Furnace & Foundry Co.,** Springfield, Mass., has awarded a contract for the construction of a new foundry building, 91 x 208 ft.

**The Richardson Scale Company,** Passaic, N. J., has issued a beautiful illustrated catalog describing its automatic weighing equipment, including the Merrick conveyor weightometers.

**The Sarco Company, Inc.,** has recently been formed by the Sarco Engineering Co. and the Roller-Smith Co. The new company will handle all sales of the Sarco steam traps and temperature regulators, with offices at South Ferry Building, New York City.

**Decks for Round-Tables.**—In the construction of cement decks for round-tables used in concentrating slime, it has been proposed to mix oil with the cement. A further suggestion is to mix with the cement oxidized linseed oil, after it has been dried and ground according to practice in making linoleum. In the latter industry, boiled linseed oil is allowed to flow in successive layers over vertical sheets of cotton "scrim," each layer being allowed to harden before the next flows on. When a "skin" of 1/2-in. thickness is thus formed, the mass is ground for incorporation with resin, kauri gum and ground cork to form linoleum. The addition of linseed oil thus prepared to cement for use on a table deck might improve the surface for collecting and holding mineral.

**Magnesite from Greece.**—Magnesite may be obtained from Greece without difficulty, according to Commerce Reports, published by the Bureau of Foreign and Domestic Commerce, Washington, D. C.